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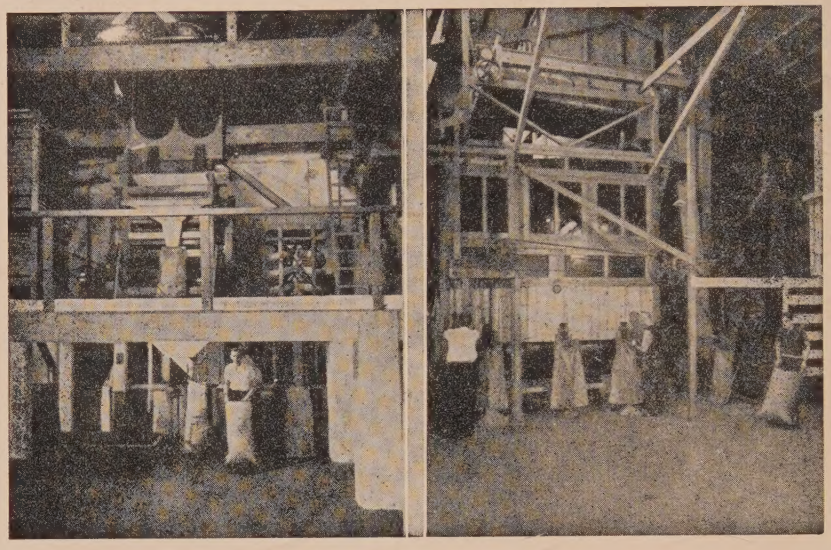

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ARTICLES

TRAVEL LEAVE FOR AGRICULTURAL SCIENTISTS

By PROFESSOR G. A. CURRIE

Vice-Chancellor, University of Western Australia

Australia has been riding along pretty comfortably on the sheep's back lately while the price of wool has been high, and wheat, meat, butter and cheese have all helped to make the ride easy going. The farmers themselves, except the unfortunate, and the inefficient, are handling more money than they have seen for a long time. It's good and healthy that the man on the land is getting a fair share of our natural wealth for he's had to take the lesser share often enough, so let's hope he'll continue to prosper.

At the same time as the farmer is getting the means to take a big stride forward in farming practice, the professional officers on the staffs of State Departments of Agriculture, men who play a very big part in rural economy, science and education, are being denied at least one of the most useful opportunities for new knowledge and new vigour which any men can get. That opportunity is to see how things are done in other advanced regions of the world; in a word—overseas travel.

Value of Travel

Anyone who gets the chance to travel is constantly astonished at the number of valuable things which can be seen abroad not clearly explained in publications. The very great improvement in scientific development and enhanced keenness in most people fortunate enough to travel abroad for study is a matter of everyday observation. Mind you, the officer who has worked in one district as an adviser or agricultural specialist, so that he knows every farm and every problem in it, is a pearl without price, but when he reaches that stage, then is the time, I say, to give him his chance to travel for new energy, new vision, and even new knowledge.

The Commonwealth allows a good deal of travel for its departmental officers, and the C.S.I.R. has been very good indeed about travel, but the State departments have rarely sent men abroad, and then only for special crop studies or specialist investigations.

Sabbatical Leave

My plea is for something like sabbatical leave for the middle range of agricultural advisers and the other professional officers of the State departments. After some seven to ten years' service they are in a position to get the best out of overseas travel and that's just when they can least afford it, especially if they have young families. Their salaries are not enough to let them go so their travel would have to be subsidised by their own government. If governments met the fares most of the men would, I feel sure, be willing to find money themselves for maintenance. Naturally, they could not all go together, but five per cent. could surely be allowed to go yearly for a six-month's survey of farming and scientific advances in farming areas and research stations where they could learn most.

It's unfortunate that the United States of America is the most fruitful place for studying agricultural problems and practices at the present time, because dollars are more difficult to find than most other currencies. Dollars are being found, however, for Commonwealth officers and business men, so it should not be beyond the powers of States to get some dollars to assist their own officers whose whole lives are devoted to service of the State, to refresh their minds and renew their energy by visiting the United States.

Much to learn

There is so much to learn in the incredibly productive farms of Iowa and other parts of the rich Middle West about dairying, breeding, maize growing, hog and poultry raising, farm lay-out for maximum efficiency, use of farm machinery, farm economics and a multitude of other scientific studies that a visit to that region alone is a revelation.

Add to that the specialists' interest in Californian fruit growing or the grazing and water conservation problems that are being so scientifically tackled in the arid research stations of Arizona, New Mexico, and other dry states; or rural education in 4 H clubs and other agencies, the famous Tennesee Valley developments, and we see that America offers a wide variety of expert knowledge from which Australian agriculture could benefit greatly.

Naturally other lands offer something, too: Europe has not stood still in agriculture; Argentina plays an ever-increasing part in agricultural production, and the developments in China and Asia are all of interest and value. Just at the moment, however, in many things, the United States has established a lead in agriculture as in industrial productivity.

Reaction of States

The harassed under-secretary for Agriculture fighting as he always is to increase his staff, to increase his service to agriculture, to improve conditions for his staff, and to improve existing branches, may not see this as important. He may say—"For heaven's sake, don't talk to me now about sabbatical leave for overseas travel, I haven't enough staff now to do the things I want to do for farmers, so how can I spare any to go away, much less pay them to go. There are lots of things I'd want to do before going in for such frills."

I don't believe this kind of thing is a frill. The departments will always be battling to expand, to improve working conditions and so on, but I believe this matter of study leave travel should take its place with those other things considered essential to build a first-rate service, working at top enthusiasm and efficiency.

It's just possible that the Fullbright Act may help, if ever it is approved for Australia. It will be used chiefly to bring American scientists and others to work in Australia, but the five million dollars credit which the United States has lying in Australia may be used in part to allow Australian scientists to reach the shores of the United States in Australian ships, so agricultural scientists should be able to take part in the scheme.

This scheme would be a temporary help only, the main responsibility must properly devolve in the long run on State Departments of Agriculture to give added service to agricultural interests in their States by developing a study leave scheme for their own officers.

THE EVOLUTION AND DOMESTICATION OF A CROP PLANT

By R. A. SILOW

In the course of this paper I propose to give some indication of the wide and comprehensive nature of modern genetical investigations. As a basis for my discussion I am going to give an account of the development of just one of our domesticated crops—a development which has proceeded side by side with the development of human civilisation. I propose to take my illustrations from the cotton crop, for this is a crop with which I was personally concerned during a recent eleven-year period of residence in Trinidad, in the British West Indies, where I held an appointment at the Cotton Research Station.

Empire Cotton Growing Corporation

This Cotton Research Station was established in 1926 by the Empire Cotton Growing Corporation, whose responsibility it is to encourage the growth of cotton within the British Empire. At the time when this station was established, a considerable amount of effort had already been put into cotton breeding in many parts of the world. Some of this had been straight selection work, which, within its limitations, had been quite successful. However, in the development of any crop in new areas of cultivation, we have to contend with many major problems of acclimatisation and adaptation. To meet these problems especially, hybridisation programmes involving many types of crosses had been very extensively performed. Few, if any of these, however, had met with any success.

The Empire Cotton Growing Corporation was not solely concerned with the breeding of improved crops for certain restricted areas, but also to look at the problem on a world-wide basis, and take into consideration the various factors which had made cotton a successful crop in certain parts of the world, and those factors which had restricted its development in others. Moreover, it was necessary to understand the scientific basis of these considerations. The Corporation saw clearly, that much more fundamental knowledge of the genetics and physiology of the cotton plant was required, before further significant advances in cotton breeding could be expected. Accordingly the Cotton Research Station at which I worked, was established solely for the fundamental long-range study of the characteristics of the genus as a whole. Whilst the more short-term and immediate problems of the cotton growers were made the concern of a series of plant breeding and agronomy stations in various parts of Africa and the West Indies.

Taxonomy and Genetics

In this, I am going to stress the importance of taxonomy in relation to genetics. Taxonomy, the branch of science which deals with the classification of living organisms into groups (families, genera and species), on the basis of their similarities and relationships, is of two kinds. Firstly, there is the classifica-

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R. A. SILOW, D.Sc., recently visited Australia on his return from the Pan-Pacific Science Congress in New Zealand, where he was representative of the British Genetical Society. Dr. Silow has been Director of the Science Office of the British Council in China, and was formerly Assistant Director of the Cotton Research Station, Trinidad. This paper is a summary of his address to a joint meeting of the Victorian Branch of the Australian Institute of Agricultural Science and the Melbourne University Extension Committee, delivered on May 16, 1949.

tion of organisms on the basis of their external morphology (or shape) and anatomy (or internal structure). This is the kind of classification which results largely from observational studies of material in herbaria or museums. The second kind of taxonomy, which is based on the experimental study of living organisms—biosystematics as it is called —is of much more recent growth, and involves studies of the way in which organisms live, the way in which they have evolved, and the way in which they breed and pass on their characteristics from one generation to the next. This kind of taxonomy then includes experimental studies in physiology, in cytology (the chromosomes), and in crossing behaviour and in genetics.

We cannot commence a genetic investigation until we know something about the external and internal characteristics of the organisms with which we are dealing. Therefore, the first kind of taxonomy provides the basis from which experimental genetical investigations commence. Then as we progress and obtain further information from physiological and genetical studies, so the primary morphological classification becomes further clarified, and results either in substantiation of earlier ideas, or on their revision and replacement.

Let us see the application of this work to the genus *Gossypium,* which includes the cultivated cottons and their wild relatives. The aim of the breeder is, of course, to replace existing populations of animals or plants by populations which exhibit more desirable characteristics—greater yield, greater hardiness, increased longevity, and so on. The breeder therefore is interested in the hereditary make-up of populations, and one of the most clearly recognisable categories of populations in nature is the species. The breeder, therefore, is particularly concerned with the nature of species—their composition, their delimitation and their relationships with other species.

The Nature of Species

Our primary concern in cotton was accordingly the elucidation of the nature of species in this genus. The first part of this paper will deal briefly with our cytological and genetical investigations and their effect on our conception of what constitutes a species, and how this has affected the classification of cottons.

We have found the comparison of the behaviour of clearly-recognisable Mendelian genes in crosses between various populations of the greatest value in assessing the degree of relationship between the populations. A simple character such as flower colour, or leaf shape, may show perfectly clear Mendelian segration into the expected 3:1 proportion of dominants and recessives in an inbred progeny where the parents which were crossed were members of the same population. If, however, the parents crossed together were members of distinct populations, the previously clear-cut dominant and recessive classes may be blended into one another, and the extent of this blending or blurring of segregation is a measure of the evolutionary differentiation between the parents. The blending in segregation reaches a maximum where the parents crossed together were selected from widely divergent species. Here, therefore, Mendelian analysis has proved to be an invaluable analytic tool in evolutionary studies and studies of this type engaged a great deal of our attention.

The second part of this paper will be a discussion of the course of evolution and domestication of cotton as a textile plant, as deduced not only from our experimental investigations, but also from such evidence as can be obtained from archaeological sources and historical writings. This second section, which makes a rather romantic story, will give some idea of the multitude of considerations which have to be taken into account in such evolutionary investigations and it will show how the results of investigations in one field, as in cotton, may throw quite

unexpected light upon some of the problems of other apparently unrelated fields —in this case, on the probable course of development of human civilisation in the New World. This general applicability has led me to choose the cotton crop for discussion, although I realise that it is not of overwhelming concern to Australian agriculture.

There have been five of us concerned with the programme of research in Trinidad. They are S. C. Harland, S. B. Hutchison, S. G. Stephens and myself as geneticists, and A. Skovsted as cytologist. It has been an essentially co-operative programme of research with a continuous aim always in the background. The most conspicuous feature of the cottons, when we first started work on them in Trinidad, was the extremely confused taxonomic situation amongst them. At least 150 species had been described in the literature, but nothing was known of their inter-relationships, and their extreme variability makes their classification very difficult.

Amongst taxonomists there have been two schools of thought. There have been those who have described a multitude of forms as species. This has often resulted in a mere extensive cataloguing of species, which may give no information on biological and evolutionary relationships. A second group of taxonomists has explained crop variability by postulating the existence of a small number of primitive, distinct, well-separated species, which have come together and given rise by hybridisation to the welter of forms now observed. The true nature of this variability has, however, been pointed out by Vavilov, who demonstrated that the areas in which variability is greatest are the areas in which the crop originated, or at least has been established longest. He concluded that variability is primitive, and not the consequence of recent hybridisation. It is in fact now generally recognised that variability, not uniformity, is a characteristic and essential feature of most natural populations. This realisation naturally affects our conception of the limits of a species.

Cytological Investigations

The initial stage in our investigations was to get together an extensive and representative living collection of the cultivated cottons and their wild relatives from all parts of the world. The first phase of our investigation of this type-collection was to make a survey of chromosome numbers. From this it was established that all of the wild relatives of cotton have thirteen pairs of chromosomes, and that the cultivated cottons of the Old World have the same number. We speak of these species as the diploid species. On the other hand, the cultivated cottons of the New World were found to be tetraploids, with twenty-six pairs of chromosomes.

On the basis of studies of cross-compatibility between species, and of cytological behaviour in the resultant hybrids, we found that the diploid species could be classified into five distinctive groups. This grouping conforms to their distribution into five major geographical areas— Australia, Indo-Arabia, Africa-Arabia, Asia and America.

Crosses between pairs of species within the geographical groups which I have described were usually relatively easy to make, but crosses between species from different geographic groups were only made with extreme difficulty, if at all. Often they give only empty seeds, and in the rare instances where they are successful, give highly sterile hybrids.

These differences in compatibility relations are associated with differences in cytological behaviour. In crosses between species within a single geographic group, there was usually complete pairing of the paternal and maternal chromosomes at meiosis in the formation of reproductive cells, indicating close cytological affinity between the parents.

On the other hand, the amount of chromosome pairing at meiosis in hybrids between species from different geographic groups was very small. Out of a possible thirteen pairs, the maximum obtained is about five, and some hybrids show no pairing at all. Evidently each of the geographic groups of species is characterised by a distinctive complement of chromosomes, indicating that the geographic groups have been separated from one another for a long time and have evolved in different directions.

Genetical Investigations

Within each of the cytological groups, cytological studies could contribute no further information, and it was necessary to turn to genetical studies in order to determine the limits of species, and their relationships. These genetical studies consisted in the genetical analysis of plant populations as they exist in nature and in cultivation, and also the analysis of hybrid populations obtained by crossing. It was this phase of the work with which I was most concerned. It involved the close study of many hundreds of thousands of plants of controlled parentage over several generations, with carefully controlled comparison of the range of variation in different hybrid populations, and analysis of the data in Mendelian terms.

Also, within these cytological groups, the fertility or sterility of hybrids was of the greatest importance in assessing the relationship of their parents. Where hybrids were very highly sterile, it could in general be concluded that their parents were members of distinct species.

Many hybrids were, however, fully fertile. Could we regard this as evidence that their parents were members of a single species, as would be the usual conclusion? There are many different definitions of a species, but the one of greatest value to the breeder, and the one which is most nearly in accord with biological considerations, is that a species is "a population within which free interbreeding is potentially possible."

Free interbreeding can only be said to take place if full fertility and full vigour of hybrids extends into their later generations. It was this criterion which was accepted as the true distinction between species and it is evidently dependent upon the maintenance of a physiological balance amongst the genes. The genotype of a species may thus be regarded as an internally co-ordinated system of genes which act harmoniously together to give a balanced organism.

Evidently each species is characterised by a particular assortment of alleles (or gene alternatives) at the very large number of gene loci involved. It is by the separation of different alleles at many loci, into different lines of descent, that the species have arisen. The much less frequent chromosomal mutations, of course, later become superimposed upon the gene divergencies, so that species more widely separated are characterised by differently constituted chromosome complements, as well as by differently constituted genotypes. Thus it is that the main cytological groups which I have already described in this genus have arisen. The earlier stages of divergence between species are clearly dependent upon gene mutation, and the substitution one for another of the products of mutation in different lines of descent.

That this genetic conception of the species is valid is substantiated by evidence from areas where two cross-compatible species are habitually grown together in mixed cultivation, as they are in parts of Western India, North-Western China, and the West Indies. In these areas, in spite of free intercrossing and the appearance of first generation hybrids in the field, representatives of later generations, being unable to compete with their parental types, are practically never found, and the integrity of the parental

species is maintained unimpaired. Here, evidently, is the explanation of the failure of so many of the earlier cotton breeding programmes which involved hybridisation.

As a result of our studies, the hundred odd so-called species of cultivated cottons have now been reduced to only four species. Many of the species established by the herbarium taxonomist, or by the field worker with only a limited knowledge of the full range of variability existent, were found to be based on only relatively unimportant single gene differences, such as those involved in leaf shape, flower colour or anthocyanin pigmentation.

Evolution of Cotton Plant

Cotton has a very extensive world-wide range, and we became interested in explaining this wide distribution. Looking at the more primitive types first, we find that the wild diploid species are scattered over the whole of the circum-tropical belt. Their large, heavy seeds are not adapted to dispersal by wind or by ocean currents. The cytological studies which I described earlier showed that they must have been separated into the four continents—Africa, Asia, America and Australia—an extremely long time ago, and the most reasonable explanation of their present distribution is based on a theory of continental drift, though I realise that this theory is not regarded with favour by the majority of geologists. Wegener has postulated that the continental masses of South America, Africa, South Asia and Australia constituted a single land block south of the equator, in the Jurassic age. Wulff, a German palaebotanist, has shown that a desert area, of the type of climate which the wild species now favour, extended at that time diagonally across this postulated landmass from what is now Peru to Arabia. It may therefore be suggested that the present-day wild species of cotton have been derived from a primitive *Archegossypium* which existed in this postulated Antarctic land mass in Mesozoic times, some two hundred to three hundred million years ago.

Now the wild species of cotton are all of small population size, confined to tropical areas, and where they occur, they are relatively unimportant components of the local flora. On the basis of them alone we would say that *Gossypium* is a static or receding genus composed for the most part of ancient relic species.

Yet the cultivated cottons provide a striking contrast. They are of great genetic variability, and have an enormous geographic range. How can we explain the obvious recent re-invigoration of the genus, and its undoubted success in association with man. We must now consider the factors that made cotton of interest to primitive man.

The success of the cultivated cottons was apparently dependent upon the emergence in the genus, of two new characters. The first of these was convoluted lint hairs, the appearance of which made spinning possible. These hairs are unicellular outgrowths of the epidermal cells of the seed coat. At first these elongations are thin-walled, but later cellulose is deposited on the inner surface of the wall. X-ray studies show that the cellulose of the cotton fibre is deposited in a spiral pattern. In the wild species, the secondary deposition of cellulose continues until the central lumen of the cylinder is obliterated at maturity, and the hair becomes a practically solid cylinder of cellulose. In the cultivated cottons, the rate of deposition of cellulose is slower, so that by the time the capsule containing the seeds is ripe, the cotton hair is still a hollow cylinder. This collapses on drying into a flat ribbon, and the strain set up by the spirally deposited layers of cellulose causes the ribbon to twist on its longitudinal axis, giving the characteristic convolutions of cotton lint from which the necessary "cling" or friction between hairs is derived which makes spinning possible.

The change in the rate of deposition of cellulose, which made the cotton plant of potential value to man, is an absolutely fundamental change comparable with those changes which made the cultivation of cereals possible—for example, the non-shattering rhachis of wheat, and the non-articulated grain-base in oats. When this change in the nature of the cotton seed hairs occurred, we cannot now say with any certainty. Our most useful evidence in this connection comes from archaeological studies. The earliest evidence of the utilisation of cotton by man comes from the excavations of the ruins of Mohenjo-daro, in the Indus Valley, in Sind. These ruins are dated about 3000 years B.C.

Domestication of Cotton in Old World

We may presume that the domestication of cotton occurred somewhere in that general area, because we have no evidence of cotton being grown anywhere else until more than 2500 years later. When Herodotus wrote in 445 B.C., the textiles of Babylonia and of Egypt were still of the earlier-domesticated wool and linen, notwithstanding the existence of cultural contacts between Mohenjo-daro and Babylonia.

The first evidence of cotton in Egypt comes from Meroitic graves in Nubia in the Upper Nile Valley, dating rather broadly some two or three centuries on either side of the commencement of the Christian era. All of the earlier Egyptian mummy clothes, some of which date back to 5500 B.C., are of linen. The first historical account of cotton outside the boundaries of India was given by Theophrastus in 350 B.C., who described the wool-bearing trees of Tylos, now known as Bahrein, in the Persian Gulf.

Evidently, then, cotton was first domesticated somewhere in the region of the Indus Valley. When this occurred we cannot be sure. All we can say is that the mature craftsmanship of the fragments of cotton yarn found at Mohenjo-daro show that cotton was evidently not a new crop at that period, 5000 years ago.

The further extension of cotton was made possible by the development of a second new character, the annual habit. All the wild species of cotton are perennial plants restricted to tropical regions, and completely intolerant of frost. So also are the primitive representatives of the cultivated species. The accounts of such early travellers as Marco Polo, referring to the growth of tree cottons, leave no doubt that in India cotton was entirely perennial right up to the thirteenth century. It was only with the development of the annual habit, by the selection of types with a short growing season, that the extension of the crop into areas subject to frost became possible.

The extension of the cotton crop in the temperate zone is comparatively recent. For example, historical records show that cotton was first introduced into China as an ornamental flowering garden plant in the seventh century. It was only a mere seven hundred years ago when the Emperors recognised that cotton formed a particularly useful commodity as a medium for the collection of taxes, that its growth was encouraged in China. Even within tropical areas also the development of the annual habit has been a most important factor in facilitating the extensive cultivation of the crop on a plantation scale in the presence of diseases and insect pests, since by growing a rapidly-maturing crop it can be harvested each season before diseases and pests have multiplied to epidemic proportions.

From its primary site of first large-scale domestication in Sind, cotton spread independently in two directions: (a) north-westerly through Persia into Asia Minor and the Levant countries, and through Afghanistan into Central Asia and Chinese Turkestan, as *Gossypium herbaceum;* (b) easterly by way of the Delhi Cap and the Ganges Valley as *Gos-*

sypium arboreum. The Sind Valley civilisation was founded on wheat, which is there near its southern limits of cultivation; only when this civilisation had reached the shores of the Bay of Bengal was rice found and domesticated, so that the further spread of cotton, south into Peninsula India, and south-east into Burma, China, and the Malay Archipelago, was dependent on the extension of rice-eating civilisations.

New World Cottons

Up to this point I have dealt only with the development of cotton in the Old World. Let us now turn to the development of the cultivated cottons of the New World. These, as I have already mentioned, are all tetraploids, with double the number of chromosomes carried by all other cottons.

Cytological evidence first brought forward by Skovsted in 1934-7 suggested that the tetraploid cultivated cottons of the New World are derived from a hybrid of Asiatic and American parentage (amphidiploids). This hypothesis was based on a comparative study of the nature of chromosome pairing in a wide range of artificially-produced interspecific hybrids in the genus, and on differences in size of the chromosomes in the various geographic groups of species—differences which persisted and could be identified in their hybrids. It was shown that the chromosome complement of the New World cultivated cottons consisted of thirteen large chromosomes homologous with the set of similar size in the diploid Old World cultivated cottons, and thirteen rather smaller chromosomes homologous with the thirteen small chromosomes of the American wild diploid species. Further, Skovsted showed that the New World tetraploid complement of chromosomes has only a very low degree of homology with those of the diploid species of the Africa-Arabian, Indo-Arabian and Australian groups.

Evidently it is only from a hybrid between an Asiatic species and an American species that a choromosome complement similar to that of the New World cultivated cottons could be synthesized. Skovsted's conclusions have been confirmed cytologically by other workers, and fully supported by various lines of genetic evidence, and more recently by artificial synthesis of an amphidiploid similar to the New World cottons by means of the colchicine technique, which was not available at the time Skovsted first propounded his hypothesis.

A "theory" of evolution

Of the parentage of the New World cottons there can now be no doubt; but our next difficulty was in explaining how and when the Asiatic and American parent came together to form the initial hybrid. No fossil evidence is available to us, and the remainder of our hypothesis is largely conjectural, but it does offer the best interpretation of the facts as known at present.

Briefly, it may be said that contact between these two parents must have been by way of the Pacific rather than the Atlantic. We have two reasons for saying that: firstly, in the Old World *G.arboreum* had long been in contact with the Pacific, whilst *G.herbaceum* reached the Atlantic only recently; and secondly, on the American continent the wild species which occur there are confined to the Pacific side of the Great Divide.

There have been two theories of contact, the first of them a theory of ancient contact, which suggested, for various reasons, that hybridisation of the parental species occurred somewhere in Polynesia in late Cretaceous or early Tertiary times, followed by migration of the new species across a land bridge which at that time may have extended from the Australia-New Zealand-New Guinea area through Samoa to South America.

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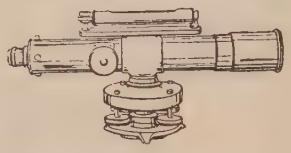

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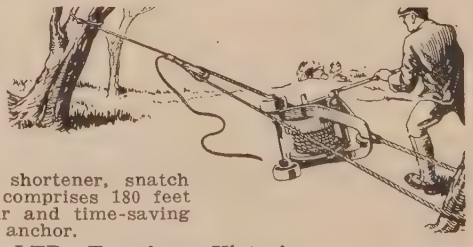

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There are various objections to this theory, and the chief of them is a geological one. Those geologists who admit the possibility of a land bridge across the Pacific do so no later than the Cretaceous, whilst palaeo-botanical evidence indicates that the major sub-generic groups of flowering plants were not established until later, in the early Tertiary.

The possibility of migration by land, by way of the northern route, is precluded by the complete intolerance of frost which is exhibited by the genus, so we are led to the conclusion that man must have taken cotton along with him on early colonising expeditions from South Asia across the South Pacific to South America. This is against all current orthodox ethnology which maintains that the American continent was originally peopled solely by way of the Behring Straits and Alaska. Yet we have sound reasons for our suggestion of direct cultural contact across the Pacific. The centre of variability of the New World cultivated cottons is in north-western South America, showing that it is here that they originated. In that area there is only one wild diploid species, *Gossypium raimondii,* of Northern Peru. Of the eight wild species on the American continent, cytogenetical and botanical evidence indicates that one of the most closely related to the cultivated amphidiploids is that same species, *G.raimondii.*

Our suggestion of recent prehistoric cultural contacts between Southern Asia and South America across the Pacific is supported by archaeological evidence. In the desert graves of pre-Inca Peru have been found spinning and weaving instruments used by the earliest known South American cultures. The spindles are the same as those used by the fine spinners of Dacca muslin in India. The distribution on the American continent of the two basic types of loom is of considerable significance. The more primitive warp-weighted loom was used for weaving wool and flax, both of which are coarse and long fibres in comparison with cotton. It apparently originated in the Mediterranean flax areas; it is found all over Europe, but on the American continent in Alaska only. South of Alaska no loom of any type is found until the south-west corner of the North American continent is reached. Here, in the cotton areas of the New World, is found the more complex double-bar loom, which was developed in the cotton and silk areas of the Old World to deal with fibres more pliable and softer than wool and flax.

Wherever cotton occurs in the New World the double-bar loom has been found, from the South-west right down to Peru, where specimens have been recovered from ancient burial sites. In none of these areas is the warp-weighted loom found. The double-bar loom is an intricate piece of apparatus involving at least eleven independent inventions. It seems most unlikely that such an assemblage of developments, identical with that which had occurred in the Old World, should have appeared by independent invention in the New World. Yet north of the cotton areas in the New World this loom apparently never did exist.

Independent biological and ethnological data therefore support the view that the cultivated cottons of the New World arose in comparatively recent prehistoric times, and that man himself was responsible for the transference of one of their parents across the Pacific Ocean. Just how recently this occurred we cannot say—all I can say is that recent archaeological excavations suggest that man's antiquity in the New World may well be much greater than we realize at present.

Cultivated Cottons in the New World

The more southerly species *Gossypium barbadenese* is widely cultivated in the northern countries of South America and in the West Indies as a perennial tree

cotton, and its annual derivatives, the Sea Island cottons of the West Indies represent the highest pinnacle of achievement of quality in cotton, with soft silky fibres 2 in. long. The high quality of these Sea Island cottons has also gone into the valuable Egyptian crop. But all of these *barbadense* types are of relative insignificance when compared with the more northerly species, *Gossypium hirsutum,* which is by far the most successful species in its modern man-made environment. Starting from perennial forms in the coastal plains of Central America, annual forms were developed in the Central American highlands, probably by the Aztecs or their predecessors. From a camparatively small area in Mexico these upland cottons first spread into the Southern United States in the early seventeenth century. Then, displacing native types, they have gone more recently into nearly every important cotton-growing area of the world, until they now produce well over half of the world's crop. This is one of the most remarkable chapters in the history of domestication of any crop. They are fast becoming the main component of the crop in India, China, Japan, Russia, Africa, Brazil, and the Argentine, primarily on account of their good quality, high yield and wide adaptability.

Conclusion

The story just related presents a remarkably romantic picture of the course of evolution of just one of the many domesticated plants and animals upon which man's whole existence and future development is dependent. Yet we know pathetically little about our crops and livestock from the biological standpoint. The only way in which this necessary knowledge can be acquired is by the extension of facilities for the investigation of the fundamental problems concerned.

Such countries as Australia and New Zealand are, of course, extremely dependent upon their primary agricultural industries and I believe that those of you who are concerned with research policy in the biological and agricultural fields are fully aware of the importance of genetic studies in animal and plant breeding, and I hope that you will be able to give your very sympathetic encouragement to the extension of facilities for this kind of basic work.

On the other hand the development of this type of work is dependent upon a greatly increased flow of recruits into the field of genetic studies. Obviously then, the extension and encouragement of genetic work must start at the teaching level, in the universities. Then it must be encouraged in the field stations, and there I firmly believe from my experience in very many different parts of the world, that the development should be on a crop basis. Very few worthwhile advances in knowledge have ever come from the man who has had to disperse his interests and energies over a wide field of interest and a multipilicity of crops. The man of general experience is invaluable, but he seldom contributes to the advancement of the frontiers of knowledge. At the stage of development of science which we have now reached, the greatest returns are likely to come where there is a group of specialists working together as a team. Then the returns from each man are not merely additive, for multiplicative benefits arise from the mutual stimulation of several minds working together, along their different paths, towards a common goal.

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Detailed bibliographies will be found in the following publications:—

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PLOUGH DRAUGHT

By D. F. A. BRIGHT

Introduction

The stump-jump disc cultivating plough is used extensively in the Mallee for ploughing and cultivation, especially where much straw and trash have to be handled. A fourteen-disc plough of that type is in use at the Mallee Research Station, Walpeup, Victoria. It was originally mounted on steel wheels because when it was bought (during the war) the manufacturer was not permitted to fit pneumatic tyres. Wheel centres, suitable for rubber tyres, were obtained during May, 1948. The University was then asked by the Victorian Department of Agriculture to carry out tests to compare the draught of the machine mounted on steel wheels and on rubber tyres. The request stated that not only the Research Station was interested in such tests, but so also were several farmers in the district.

On the Mallee soils the standard steel wheels dig in, and impose heavy pulls (loads) on the tractor. Pneumatic tyres roll much more easily on the surface of the soil, apparently giving a marked reduction in tractor load. The main question to be answered was whether all of the plough wheels should be rubber-tyred, or whether a rubber tyre is required only on the furrow-wheel which works in the loosest soil.

No draught testing equipment was available at Walpeup, but the Division of Aeronautics of the Council for Scientific and Industrial Research had recently completed a hydraulic dynamometer for tractor testing.[1] This was borrowed for the tests and a set of shackle plates was made up to enable the dynamometer to be used in the normal tractor hitch.

We were also asked to carry out fuel consumption tests, but these would have involved too much special equipment and a great deal more time, and probably would not have given any more reliable results than the estimates, given later in the report, which are based on tractor power output calculated from the test results; therefore no fuel tests were attempted.

Design of Experiments

Originally two elaborate factorial experiments were designed to test the effect on the plough draught of the two different Mallee soils,* three sets of wheel equipment, three ploughing depths and two speeds. One of these experiments allowed for all runs on one set of wheel equipment to be run consecutively, and so required only two wheel changes. The other required frequent wheel changes, but had the advantage that the runs were randomized in time as well as in position. The intention was to use the latter arrangement if time allowed.

It was found impossible in the field to obtain the three plough settings without altering the positions of the pins in the

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*Light Soil: 0-4in. Light brown sand. 4in.-26in. Very light brown sand. 26in. + Light Brown sandy clay loam with light loam.

Heavier Soil: 0-5in. Brown to reddish brown loamy sand. 5in.-11in. Red-brown sandy clay loam. 11in. + Light greyish-brown clay with medium soft lime and light limestone rubble.

setting levers. So it was decided to use only two settings:—

(i) no cut
(ii) nominal three-inch cut.

The latter is the depth generally used in the district. It was learnt that some farmers use a rubber-tyred land wheel as well as a rubber furrow wheel, and that a high drawbar hitch is favoured in the light soil. After a short trial, frequent wheel changing was considered impracticable.

Experimental Method

The experiment was redesigned on a convenient randomization scheme with the following factors:—

1. *On the heavier soil*
   (a) four sets of wheel equipment:—
      (i) all steel wheels
      (ii) all rubber wheels
      (iii) rubber furrow wheel, otherwise steel wheels
      (iv) rubber furrow and land wheels, steel trailing wheels.
   (b) two settings, i.e., no cut and nominal three-inch cut.
   (c) two speeds:—
      (i) high gear
      (ii) intermediate gear.
2. *On the light soil*
   (a), (b), (c) as for the heavier soil
   (d) two drawbar hitch heights—
      (i) low drawbar (fifteen inches above ground)
      (ii) high drawbar (twenty-one inches above ground).

A much higher drawbar would have been better, but was not available.

The wheel equipment was used in the following order: all four steels, rubber on furrow wheel only, rubber on furrow and land wheels, all rubber tyred wheels, and then in the reverse order.

It was decided by tossing a coin whether or not to change the wheels at the end of a particular run. The plough settings and drawbar height for each run were decided at random, and the outward and return runs for each set of wheels and plough settings were made in high and intermediate gear, the order being decided at random.

In each field a flight of levels was run along the test course so that some allowance could be made for slope.

Analysis of Results

The results obtained in the field were analysed statistically, and at the same time corrected for slope; the analysis is outlined in the Appendix. It was found that all of the factors tested, except the speed, had highly significant effects on the drawbar pull. The corrected results are shown in *Table I.*

TABLE I.

TEST RESULTS: Drawbar pull in pounds required to tow the plough under various conditions of soil, drawbar height and wheel equipment.

Wheel Equipment	4 steel		3 steel 1 rubber		2 steel 2 rubber		4 rubber	
	no cut	cut	no cut	cut	no cut	cut	no cut	cut
Heavier soil, low drawbar	440	2020	290	1930	220	1710	120	1320
Light soil, low drawbar	1000	1630	570	1360	460	1290	210	870
Light soil, high drawbar	870	1430	570	1360	430	1210	230	940

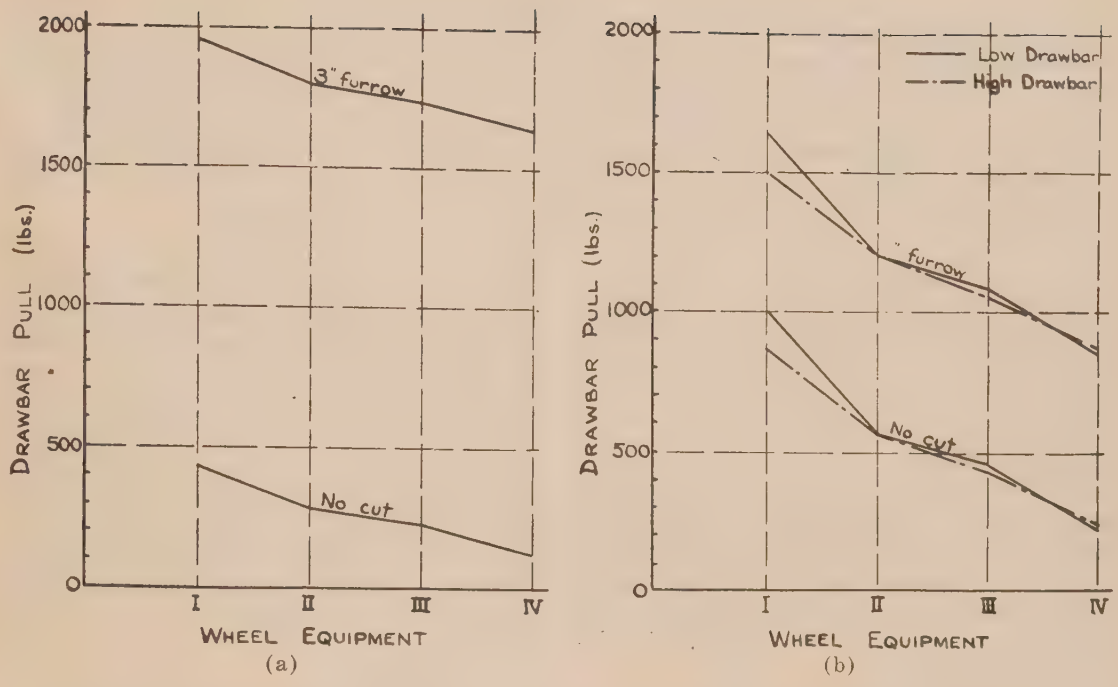

Fig. 1.

Adjusted Test Results showing Drawbar pull in lb.. for various conditions of wheel equipment.
(a) Drawbar pull on heavier soil.
(b) Drawbar pull on light soil.
(i) Steel wheels.
(ii) Rubber furrow wheel.
(iii) Rubber furrow and land wheels.
(iv) Rubber wheels.

TABLE II.

ADJUSTED TEST RESULTS: Drawbar pull in pounds required to tow the plough cutting the standardised furrow-section under various conditions of soil, drawbar height and wheel equipment, estimated as follows:

Drawbar pull = towing force + ploughing force.

Wheel equipment	4 steel	3 steel 1 rubber	2 steel 2 rubber	4 rubber
Heavier soil, low drawbar ..	1950	1800	1730	1630
Light soil, low drawbar	1630	1200	1090	840
Light soil, high drawbar	1500	1200	1060	860

Standardised cross-section of cut: 3 in. depth, 7 ft. 0 in. width.

Average ploughing pressure: Heavier soil, 6.0 lb./sq. in.;
Light soil, 2.5 lb./sq. in.

Average ploughing force: Heavier soil, 1510 lb.
Light soil, 630 lb.

Since the width and depth of cut were not the same for all runs, the results were further adjusted to allow for these differences. A standardised width and depth of cut were estimated, and used as the basis for the adjusted results shown in *Table II* and the graphs of *Fig.* 1.

Discussion

The discussion is based on the adjusted results to avoid confusion arising from the fact that the cross-section of cut was not uniform from run to run.

Wheel equipment

The tables and graphs show clearly that the use of pneumatic tyres makes very significant reductions in the pull which the tractor is required to exert on the plough. Just what this reduction means in terms of kerosene saved is discussed later.

When the plough is rolling free, a condition which exists only when it is being brought out to the job and returned to the shed, the resistance on both soils is reduced to about a quarter by replacing the four steel wheels by pneumatic-tyred wheels. The reduction is less spectacular when the plough is working, but when it is mounted on steel wheels, working in the Mallee sand, about 60 per cent. of the pull is used in moving the wheels, only 40 per cent. does the work of ploughing. For the plough mounted on four rubber tyres the proportions are about 25 per cent. lost in rolling the wheels, 75 per cent. in ploughing the soil. The saving is not nearly as great on the heavier soil, but is still highly significant.

As pointed out later, roughly half of the saving is due to the use of a pneumatic tyre on the furrow wheel. The land wheel tyre is responsible for another 25 per cent. of the saving, the rear wheels for the rest. It is claimed, though there seems to be no way of expressing this quantitatively, that the plough is easier to control with steel rear wheels than with rubber tyres there.

Slope

The slopes encountered in the field were of the order of 1 in 80 to 1 in 100. Their effect was vastly overshadowed by the differences discussed above, but it was still considered worthwhile to make some correction for them.

Speed

The analysis showed that the drawbar pull required to work the plough is not significantly different whether the tractor is in high or intermediate gear. This means that the power is proportional to the speed. As the time to plough a given area is inversely proportional to the speed, this means that the fuel used depends only on the area ploughed. In order to save time, therefore, it is better, and no more expensive, to plough in high gear wherever possible.

Power Saving

Considering the plough equipped with steel wheels as the basic unit, using a rubber-tyred furrow wheel saves about 7½ per cent. of the pull, and hence of the power, on the heavier soil; and 23 per cent. on the light soil. The other three wheels are severally not nearly as important; taken together they represent a total saving of only about 9 per cent. on the heavier soil and 22 per cent on the light soil.

The total saving in work per 100 acres is about 100 H.P. hr. on the heavier soil and 225 H.P. hr. on the light soil. This should mean a saving of about 15 and 34 gallons of fuel per 100 acres, respectively.

Drawbar Height

The drawbar height has a significant effect on the force required to tow the plough on light soil. The high drawbar decreases the towing force except for the rubber-mounted plough, when it increases it. This last does not seem logical; further tests with a greater difference in drawbar height might yield different results in favour of the high drawbar and all pneumatic tyres. This does not mean, however, that power is saved

by using the high drawbar. The high drawbar transfers some of the load from the plough wheels to the rear wheels of the tractor, thus increasing their rolling resistance; so the total tractive effort is practically unchanged.

Conclusions

The use of pneumatic tyres reduced the force required to pull the plough, as was expected. About half of the saving was due to the rubber-tyred furrow wheel.

The force required to pull the plough was independent of speed in the working range.

Equipping the plough with rubber tyres instead of steel wheels may be expected to save up to thirty-four gallons of kerosene per hundred acres.

Increasing the drawbar height usually reduced the pull required by the plough.

Acknowledgments

There are three groups of people to whom thanks are due:—

Mr. J. McCann, manager of the Mallee Research Station, Walpeup, Victoria, from whom came the original request for the investigation, and who made all the local arrangements for the experiment to be carried out at Walpeup. With him I must thank those of the Research Station staff who helped in carrying out the experimental work, and Messrs. E. Gneil and G. Williams, who gave up their time to drive the tractors used in the tests.

The Division of Aeronautics of the Council for Scientific and Industrial Research for lending their dynamometer for the tests, and particularly Mr. D. Pescod, who came to Walpeup to look after the instrument and assist in the tests.

Mr. J. R. Bainbridge, formerly of the Melbourne University Engineering School, for his invaluable aid in the statistical design of the experiments and the analysis of the results, and Mr. G. H. Vasey, of the Melbourne University Agriculture School, to whom the original request was directed, for his administration of the job and his friendly help and advice throughout.

APPENDIX

Statistical Investigation

The first statistical test carried out on the results was intended to find whether speed and slope (which were confounded) had any effect. On the heavy soil, five readings of drawbar pull were taken on each run. The outward run was made uphill, the return run downhill, and the five readings in each run were made at corresponding points. Thus readings 1 to 5 were obtained running uphill, 6 to 10 downhill, so that the latter set would be expected to be lower than the former (see *Fig.* 2).

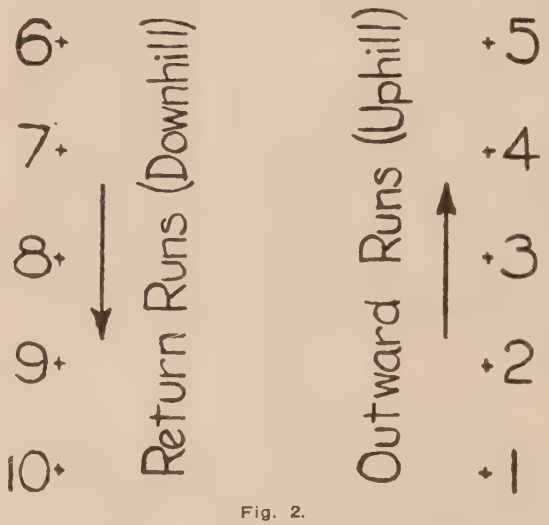

Fig. 2.
Layout of readings on heavier soil.

To allow for variations of soil along the field, the results were grouped in pairs (one with 10, 2 with 9 and so on) and the differences found. The mean difference was found, and tested for significance. The results for high and intermediate gear were tested similarly. Neither mean difference was significantly different from zero, so it was concluded tentatively that speed and slope could be neglected on the heavy soil.

Heavy Soil

The results for the heavy soil fall into two groups, the northward and southward runs, because of:—

(i) the slope, despite the tentative conclusion just drawn and
(ii) the distance (about 2 chains) separating the runs.

The results were also grouped into "cut" and "no-cut" runs, and the four blocks analysed in 5 x 4 tables (5 replications of 4 factors) for differences between positions in the run and between wheel arrangements. This analysis showed highly significant differences between wheel arrangements, and in two blocks significant differences between readings taken at different points. The readings range from about 100 to 2000 lb., so the analysis was repeated using the logarithms of the readings. This yielded precisely the same results, with the advantage that the magnitude of the numbers was now more uniform; but a test of the residual mean squares indicated lack of homogeneity, apparently in the northbound runs. The areas of cross-section of cut were analysed in the same way as the drawbar pulls; this analysis showed no significant differences either within each run or between runs, so it failed to explain the earlier results.

Light Soil

The results for the light soil fall into eight 4 x 4 blocks, four for each of two drawbar settings. The analysis of the logarithms of the drawbar pull leads to very similar results to those obtained for the heavy soil—highly significant differences between wheel arrangements, and some significant differences between readings taken at different points. The residual mean squares are homogeneous. The analysis of the areas of cut show significant differences between runs, but not within each run.

The logarithms of drawbar pulls on the light soil were analysed as a four-factor experiment, as follows:—

(a) two drawbar heights
(b) four wheel arrangements
(c) two plough settings
(d) two speeds.

Allowance was made for the slope by considering a confounding term $+a$ in the westbound (uphill) runs, $-a$ in the eastbound (downhill) runs, determining which terms were confounded by slope, and then estimating a and correcting at the end of the analysis. Three and four-factor interactions were assumed to have no physical significance, and therefore to comprise error and confounding terms only.

This analysis showed highly significant differences in drawbar pull between wheel arrangements, between plough settings and between speeds, and a significant interaction between drawbar height and wheel equipment.

Low drawbar pull

A similar analysis was carried out on the results on heavy soil and on light soil with low drawbar, using the factors:—

(a) two soils
(b) four wheel arrangements
(c) two plough settings
(d) two speeds.

Allowance was made for the difference in grade on the two soils.

This analysis showed highly significant differences in drawbar pull between wheel equipment, between soils, between plough settings, but not between speeds.

No allowance has been made in these analyses for differences between runs in the area of cross-section of cut. So a further analysis was carried out with the factors:—

(a) soil and drawbar factors—
  (i) heavy soil
  (ii) light soil, low drawbar
  (iii) light soil, high drawbar
(b) four wheel arrangements
(c) two speeds
(d) two plough settings.

The results were corrected for slope; all factors except speed were then found to be highly significant. *Table I* shows these corrected figures.

For each combination of soil and wheels, the difference between the values of the drawbar pull corrected for slope for the two plough settings was used as an estimate of the force required to plough the soil (see note). This force was divided by the corresponding mean area of cut to find the ploughing pressure, or force per square inch of cut, required to plough the soil.

The values of pressure for the heavy soil were taken together, and the mean and five per cent. fiducial limits found. Those for the light soil were treated likewise. Both sets of values fell well within the five per cent. limits.

The standardised furrow area was then adopted and multiplied by the mean pressure to obtain the ploughing forces for the two soils. This was added to the corresponding towing forces to obtain adjusted working drawbar pulls. The adjusted results are shown in *Table II* and *Fig.* 1.

Note

The method of estimating ploughing pressure assumes that:—

(i) the ploughing action imposes no extra load on the wheels; and

(ii) the ploughing pressure remains constant at all depths within the working range.

The first assumption is almost certainly untrue, but as only two plough settings were available it is the best that can be made. The second assumption is probably better, but American results with mouldboard ploughs suggest that, over a wider range of depths, the ploughing pressure depends on depth.

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(*Received for publication,* 15*th April,* 1949.)

SOME NOTES ON PLANT VIRUS DISEASES IN SOUTH AUSTRALIA

By M. A. WATSON

Introduction

These notes record the results of work carried out at the Waite Agricultural Research Institute, University of Adelaide, during a visit made in 1947. Unfortunately, there was insufficient time for the studies to be completed properly but they are recorded partly to show the scope for exploratory work among plant viruses in South Australia and partly in the hope that they may save some preliminary work in future investigations.

1. Virus diseases of Subterranean clover and garden peas

In October, 1947, some plants of subterranean clover, *Trifolium subterraneum*, var. Bacchus Marsh) growing in the grass garden at the Waite Institute, were observed to be dying, while other plants on the same plot showed a bright yellow and green mottle. Other clovers and also medics, in the same garden, had mottles of varying intensity. Specimens were selected from the dying plants of Bacchus Marsh subterranean clover, and from the mottled plants of Bacchus Marsh and Mount Barker subterranean clovers. Inoculations were made by rubbing, with celite[2] on to the leaves of seedlings of the two varieties of subterranean clover, also on to Crimson Clover (*Trifolium incarnatum*), garden pea (*Pisum sativum*, var. Greenfeast), and French bean (*Phaseolus vulgaris* var. Hawkesbury wonder).

Symptoms

The three sources of infection (dying and mottled Bacchus Marsh; mottled Mount Barker), gave the same symptoms when inoculated into the test plants, so the more severe symptoms were presumed to have been caused by the plants having become infected at an early age. The symptoms caused were as follows:—

Subterranean Clovers (Bacchus Marsh and Mount Barker strains). Clearing of the veins of the youngest leaves, and a systemic mottle consisting of stripes of greenish-yellow, and dark green, following the direction of the secondary veins. Moderate stunting in most plants, but in some, growth was severely checked.

Crimson Clover. Similar to the symptoms in subterranean clover, but the mottle was brighter and more distinct. (*Fig.* 1.)

Fig. 1.
Subterranean clover virus in Crimson Clover.

MARION A. WATSON, M.A., Ph.D., who is a plant pathologist at Rothamstead Experimental Station, England, visited Australia in 1947.

Garden pea, var. Greenfeast. Exceptionally mild symptoms. Very slight vein clearing at first, followed by systemic mottle of small dark green vein bands on a lighter background. Infected leaves tended to become yellowish with old age, but the symptoms disappeared after two or three weeks, and newly developed leaves showed little or no symptoms. (*Fig.* 2.)

fected, except that some of the plants were rather smaller than others. No mottle could be detected on the leaves, but both sap and aphid inoculations transmitted the virus to Crimson Clover and to garden pea.

Aphid transmission

The virus was transmissible by *Myzus persicae* (Sulz.) and *Macrosiphum euphorbiae* (Thomas) (*gei* Koch).

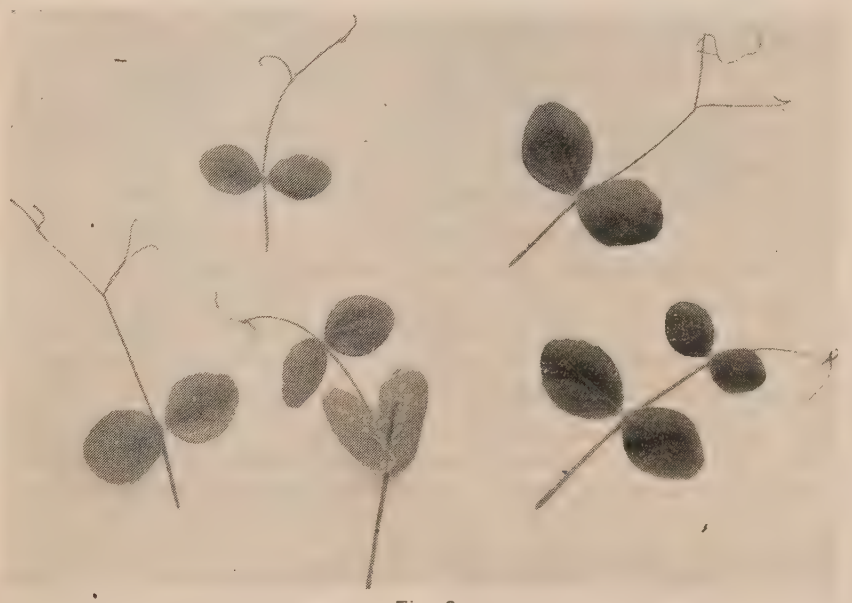

Fig. 2.
Subterranean clover virus in Garden pea, var. Greenfeast. Infected plant on the left, healthy plant on the right.

French bean, var. Hawkesbury Wonder. Fine inter-veinal mottle of dark green on a lighter background; some stunting, but no severe leaf deformation, only a slight prolongation of the leaf tips.

Other plants tested from the grass garden were:—White sweet clover (*Melilotus alba*) Barrel Medic (*Medicago tribuloides*), Tallarook subterranean clover and Dwalganup subterranean clover. All gave the same symptoms in Crimson Clover, Bacchus Marsh subterranean clover, and garden pea.

The symptoms in Tallarook subterranean clover were less severe than in the other varieties, and the Dwalganup subterranean clover appeared to be unaf-

The first transmissions to peas and clovers, were made with aphids which had been starved for several hours, and then fed on the infected plants for either two minutes or twenty-four hours. Most of the infections occurred after two minutes feeding on infected plants, which showed that the virus belonged to the non-persistent group.[4] *Table I* gives the results of an experiment made to show the results of variation in the infection feeding time, after fasting.

The identity of the virus

The ability to infect French bean distinguishes the virus from common pea mosaic, and the susceptibility of garden

TABLE I.

Transmission of subterranean clover virus by Myzus persicae.

Source of Infection	Test Plant	Time of feeding on infected leaves 2 min.	1 hr.	24 hrs.
Crimson Clover	Crimson Clover	5/5	1/4	1/4
Bacchus Marsh	Crimson Clover	5/5	0/5	1/5
Crimson Clover	Bacchus Marsh	5/5	1/4	2/4
Bacchus Marsh	Bacchus Marsh	4/5	3/4	1/2
Crimson Clover	Mount Barker	3/4	0/4	1/4
Bacchus Marsh	Mount Barker	2/5	1/4	0/4
	Total	19/29	6/25	6/23

Preliminary fasting time = 18 hours.
Time on healthy plants = 24 hours.
Number of aphids = 3 per plant.

The first figure of the fraction is the number of plants infected and the second, the number of plants tested. The variation in plant number was due to the loss of some seedlings by root infection before the experiment was carried out. Priority was given to the shorter infection feeding times, because they were likely to be of the greatest interest.

The results were according to expectation; short infection feeding gave more transmission than 1 hour or 24 hours. When *Macrosiphum euphorbiae* was used as the vector, the results were similar.

pea and white sweet clover distinguishes it from common mean mosaic (*Phaseolus* virus 1, Smith, 1934). It was provisionally identified as the subterranean clover virus described by Aitken and Grieve,[1] and this was later confirmed by Aitken.

2. "Yellow" virus of garden pea

Aitken has identified a virus disease which is common in peas in Victoria, as the subterranean clover virus, and she was unable to find common pea mosaic. A search was therefore made in gardens and commercial crops in the Adelaide area, to see if common pea mosaic could be obtained there. A virus disease was found in peas in the neighbourhood, which was transmitted by sap inoculation and by *M.persicae* to Greenfeast pea, and to subterranean and Crimson clovers.

Symptoms

The symptoms in Greenfeast pea resembled those observed in garden and field crops, and were much more severe than those caused by the subterranean clover virus. There was distinct clearing of the veins of the youngest leaves, followed by a brilliant yellow mottle with dark green streaks bordering the yellowed areas. (*Fig.* 3.) There were some necrotic flecks or streaks and the undersides of the leaves were roughened. The symptoms in Crimson and subterranean clovers were much milder than those caused by the subterranean virus, and the plants were less susceptible.

Inoculations, made by rubbing with celite, into Hawkesbury Wonder bean produced no symptoms in seventeen days, although beans inoculated at the same time with the subterranean virus, showed

Fig. 3.
Yellow pea mosaic virus in Garden pea, var. Greenfeast.

systemic symptoms in that time. The plants could not be kept under observations any longer, but the result has been confirmed by Aitken (private communication) who tested the material at the University of Melbourne.

The following experiment was carried out to test whether the pea mosaic was related to the subterranean virus:—A number of Greenfeast pea seedlings were inoculated by aphids with the subterranean clover virus. When the symptoms were fully developed eight of the infected plants were inoculated by rubbing, with Yellow pea virus, and eight healthy peas were also inoculuated. Four of the subterranean clover infected peas, and three of the healthy peas produced symptoms of Yellow pea mosaic.

This result indicated that there was no relationship between the Yellow pea mosaic and the subterranean clover virus. The manner of transmission of the pea mosaic by *M.persicae* showed that it was of the non-persistent type, which precludes it from being Enation pea mosaic (*Pisum* virus 2, Smith). The evidence suggests that it is a strain of common pea mosaic.

3. A virus from Nemesia

In August, 1947, a virus was obtained from Nemesia, grown in a private garden. The plants were very stunted. The young leaves were distorted and had necrotic flecks; some of the stems and growing points were also necrotic. It was inoculated by rubbing with celite on to leaves of tobacco, tomato, *Nicotiana glutinosa*, and *Petunia hybrida*.

Symptoms

N.glutinosa. One or two chlorotic local lesions appeared on the rubbed leaves, after about six days. The lesions grew in irregular concentric rings. Clearing of the veins appeared on the youngest leaves, followed by generalised chlorosis at the bases of the leaves and dull yellow vein clearing in the distal portions. Some leaves wilted and died.

Tomatoes. These developed typical "fern leaf" symptoms, with no mottle and little stunting. (*Fig.* 4.)

Fig. 4.
Nemesia virus in tomato. Systemic symptoms about three weeks after inoculation.

Tobacco. The plants showed no symptoms for several weeks, except that at one stage the young leaves seemed a little crinkled, and darker green than the uninoculated plants. After about six weeks the younger leaves developed deformations of the margins.

Petunia hybrida. Showed numerous chlorotic local lesions on the inoculated leaves. Some of the plants later developed slight clearing of the veins of the youngest leaves, which persisted in the older leaves as slight chlorosis in the neighbourhood of some of the veins. No infection was obtained in French beans, peas or clovers.

Aphid transmission

The virus was transmitted by *Myzus persicae*, and behaved as a non-persistent virus, see *Table II.*

The tobacco leaves on which infective aphids fed, showed a ring of faintly necrotic tissue which spread towards the margins of the leaf. Usually there were one or two small necrotic spots which may have marked the actual feeding sites where the virus was introduced.

The identity of the virus

The symptoms in tomato and the manner of transmission by *M.persicae* suggest that the virus is a strain of cucumber mosaic virus (*Cucumis* virus 1, Smith, 1934). The symptoms in *N.glutinosa* and Petunia agree reasonably well with those

TABLE II.

Transmission of Nemesia virus by Myzus persicae.

Source Plant	Test Plant	Infection feeding times		
		2 min.	1 hr.	24 hrs.
Tobacco	Tobacco	9/20	—	1/20
N.glutinosa	*N.glutinosa*	6/10	1/10	2/10
N.glutinosa	Tobacco	5/10	1/10	0/10

3 aphids per plant, fed for 24 hours on test plants.

described by Smith. The failure to cause young leaf symptoms and mottle in systemically infected plants is unusual, but this virus exists in a number of strains which cause variable symptoms in tobacco. Unfortunately, no cucumber plants were available in time for it to be tested in that host, and it was not possible to obtain known Cucumber mosaic virus, for cross immunity tests. In the absence of these tests, the identity of the virus remains uncertain, but it is likely to prove to be a strain of Cucumber mosaic virus.

4. A virus from Petunia hybrida.

The Petunias from which this virus was isolated were bushy and stunted, with mottling, distortion, and some necrosis of the young leaves. Sap from these plants was inoculated by rubbing into tobacco and tomato plants. The inoculated tobacco leaves produced only one or two necrotic ring-spot lesions, but when these lesions were isolated and the extracts rubbed on to further tobacco plants, large numbers of lesions resulted, and systemic infection followed. The symptoms occurred on only a few leaves above the inoculated ones, they consisted of small chlorotic spots, and a few necrotic rings. Leaves developing later appeared healthy, and recovery was apparently complete for sap expressed from plants eight weeks after inoculation, even after they had been re-potted, and induced to grow vigorously, produced no symptoms when inoculated into tobacco plants.

Only two out of five tomato plants become infected. The systemic symptoms consisted of isolated, small dark necrotic lesions, surrounded by yellowish haloes. Later there was some streaking of the stems near the growing points. Inoculation from these infected tomatoes gave only two or three lesions on tobacco leaves.

The virus was inactivated in sap expressed from inoculated leaves, by ten minutes heating at 60°C.

Attempts to transmit the virus by *M.persicae, Macrosiphum euphorbiae,* and *Thrips tabaci,* failed.

In the absence of further tests the virus was provisionally identified as a strain of the Tobacco ring spot virus (*Nicotiana* virus 12, Smith, 1934). The symptoms in Petunia resemble those described by Smith, and the virus is reported as being twenty per cent. seed transmitted in this host, so there is no difficulty in suggesting how the plants became infected in the absence of an insect vector. The necrotic ring-spot lesions, and especially the recovery from infection in tobacco, are generally considered to be diagnostic of tobacco ring-spot virus, and the symptoms in tomato also agree with this diagnosis, though Smith remarks that systemic infection in tomato is rare.

Acknowledgments

I would like to record my thanks to the Director and Staff of the Waite Institute for their hospitality, for the facilities afforded, and for the many kindnesses which helped to make my visit enjoyable and profitable. My thanks are also due to Miss Y. Aitken, of the University of Melbourne, for her co-operation in the work on the subterranean clover viruses, and to Mr. Phillips of the Waite Institute for taking the photographs.

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THE RELATIONSHIP BETWEEN TRACTORS, DRAUGHT HORSES AND POWER KEROSENE CONSUMPTION IN AUSTRALIAN AGRICULTURE

By I. MOLNAR

Introduction

Power kerosene (p.k.) is used chiefly in tractors and to a lesser extent in stationary engines, it having been estimated that 96 per cent. of the p.k. consumption is utilised by tractors in rural areas and only 4 per cent. by stationary engines on rural holdings, and in urban areas.* The investigation therefore involved a study of tractor numbers and the consumption of p.k. in the States of the Commonwealth. Arising out of this study a number of interesting relationships between numbers of tractors, draught horses, and consumption of p.k. has emerged, which it is desired to record in this paper.

Tractor Numbers

Investigation showed that it would be impossible to determine the geographic distribution of farm tractors by size and by types of fuel used. Time did not permit a farm-to-farm survey, so it was necessary to use overall figures for tractors irrespective of their type, and to make a study of data of tractor distribution and p.k. consumption by statistical unit areas. In spite of the fact that the total rural tractor population is a somewhat crude basis for computing the p.k. requirements of the Australian agriculture, the error so introduced is not likely to be great. It has been suggested* that the number of p.k. type of tractors in the secondary industries would roughly compensate for the Diesel type of tractors in primary industries; the petrol types could be disregarded because their number is relatively insignificant, although they may play a relatively greater part in the tractor imports in coming years.

*By the Division of Agricultural Production, Commonwealth Department of Commerce and Agriculture, Melbourne.

Kerosene Consumption

Since the p.k. requirements of the non-rural industries are relatively insignificant, the total p.k. sales in the 1947-48 fiscal year were taken as indicating the p.k. needs of the tractors on rural holdings. Oil companies kindly provided the p.k. sale figures of the whole trade, State by State, for the 1935-36 to 1947-48 period. Kerosene sales to the Armed Forces during the war years were also obtained. In addition, confidential access was given to data on sales in Victoria in 1947-48 by the larger companies. The sales by these companies were large enough to be used as a basis for the calculation of total consumption in certain selected agricultural areas of Victoria.

Factors which affect p.k. consumption in the various States

In *Fig. I* the acreage under crop, tractor numbers and draught horse population, and the two-yearly moving average p.k. sales are shown for all the States. P.k. sales are shown in this way because, especially during the war years, farmers sometimes bought in excess of their immediate requirements. The year to year fluctuation in p.k. sales is illustrated in the graphs for New South Wales and Vic-

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toria. *Fig. I* shows that, *generally*, the p.k. sale figures in all States increase with the number of tractors, while crop acreage exerts a relatively small influence on consumption. It also shows that the decrease in the draught horse population is accompanied by a corresponding rise in the number of tractors.

The p.k. consumption is not proportional to the acreage for various reasons. Firstly, consumption, as shown later by the detailed data for Victoria, varies according to the type of crop, and is the greatest in the wheat areas. Therefore, the proportion of the cereal and hay acreage to the total crop acreage will have a greater bearing on the consumption than the total crop acreage. Secondly, in a year following a drought wheat farmers often sow not only their fallowed land but also the land where the failure occurred. Thirdly, the weather conditions have also an effect, as indicated by the unusually high annual sale figu" in New South Wales and Victoria in the 1947-48 season, when the harvest was gathered under exceptionally difficult conditions. The relative importance of the various factors on the p.k. consumption is shown for New South Wales in *Table I.*

TABLE I

Correlation between	Correlation coefficients: For the 1938-39—1947-48 period.	Correlation coefficients: For the 1938-39—1947-48 period with the omission of the two seasons which were preceded by the droughts of 1940 and 1944.
P.k sales and tractor numbers	+0.93**	+0.95**
P.k. sales & draught horse numbers ..	—0.92**	—0.93**
Tractor and draught horse numbers ..	—0.89**	—0.89*
P.k. sales and crop acreage	+0.30†	+0.41†
Crop acreage and horses	—0.58†	—0.68†

**=Mathematically very highly significant (at the P=0.001 level).

* =Mathematically highly significant (at the P=0.01 level).

† =Mathematically not significant (at the P=0.05 level).

The data in *Table I* shows a high positive correlation between p.k. sales and tractor numbers, and a high negative correlation between p.k. sales and draught horse numbers, and also between tractor and draught horse numbers. The correlation between p.k. sales and crop acreage is much smaller and mathematically not significant. The importance of droughts in this matter is shown by column three of the table in which the correlations are worked out, omitting the seasons which followed the drought years. In this column the correlation between p.k. sales and crop acreage is +0.41 as compared with +0.30 for the whole period in column 2.

From the ten years' data it was possible to work out the following regression equations which are applicable to New South Wales for rough computation of the p.k. consumption in any one year. These equations are as follows:—

(a) $K = 1.50T - 9{,}670$

(b) $K = 45{,}000 - 0.156H$

where K = power kerosene consumption in thousands of gallons, T=tractor population, and H = draught horse population.

The tractor population in any one year can be computed approximately by the formula:—

$T = 34{,}300 - 0.0934H$

where T = tractor population and H = draught horse population.

In the other States the draught horse numbers have not been determined over a sufficiently long period to make a similar analysis reasonable and the best that could be done was to work out the consistency of draught horse replacement by tractors. From general agricultural knowledge it seemed likely that on the *average* a tractor might be expected to replace ten draught horses. Using this assumption the annual draught horse figures on farms in each State were divided by ten and the number of tractors added to give a measure of tractive power available on farms. The results are set out in *Table II.*

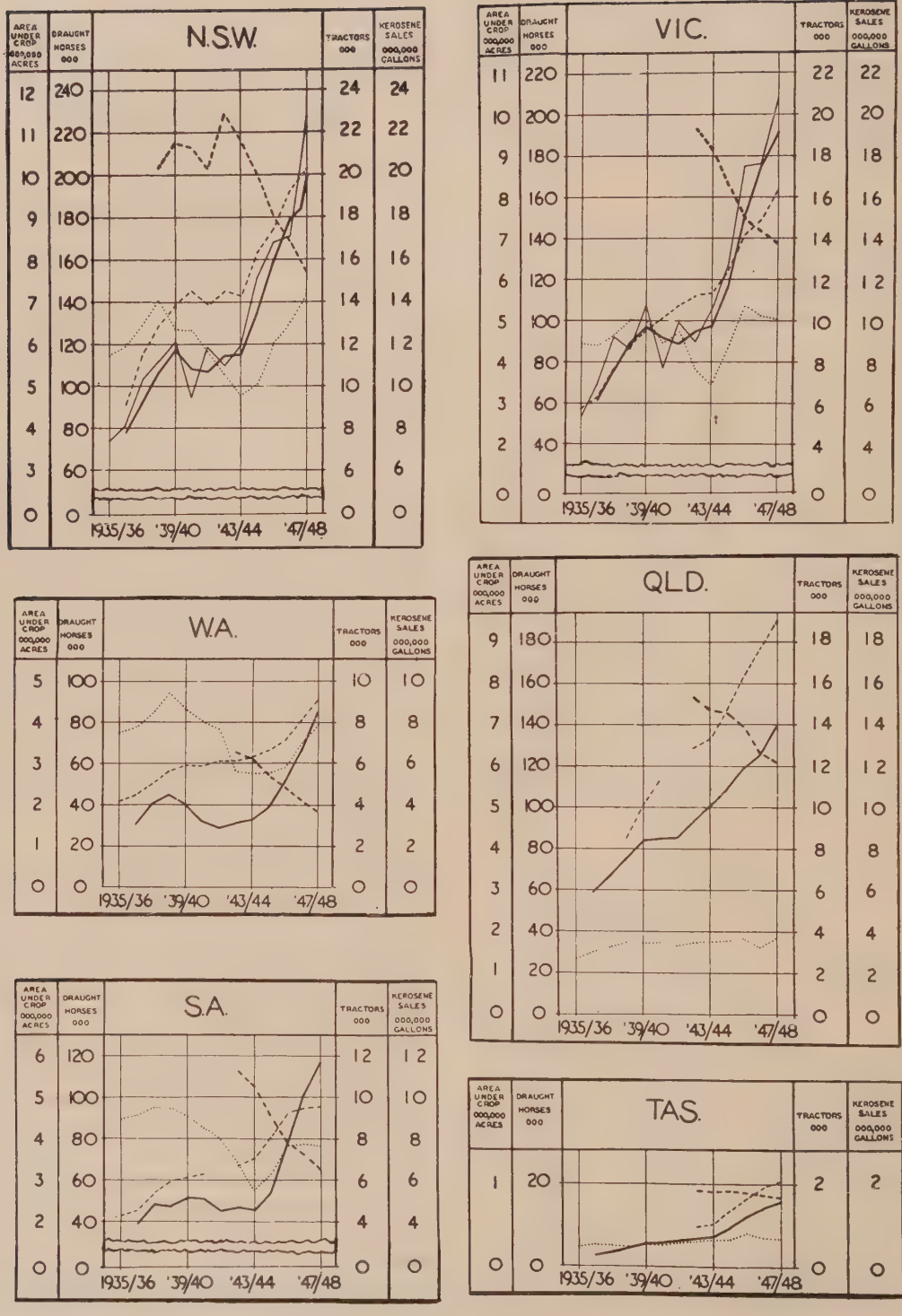
N.S.W.
AREA UNDER CROP 000,000 ACRES
DRAUGHT HORSES 000
TRACTORS 000
KEROSENE SALES 000,000 GALLONS
12 11 10 9 8 7 6 5 4 3 0
240 220 200 180 160 140 120 100 80 60 0
24 22 20 18 16 14 12 10 8 6 0
1935/36 '39/40 '43/44 '47/48
VIC.
11 10 9 8 7 6 5 4 3 2 0
220 200 180 160 140 120 100 80 60 40 0
22 20 18 16 14 12 10 8 6 4 0
W.A.
5 4 3 2 1 0
100 80 60 40 20 0
10 8 6 4 2 0
QLD.
9 8 7 6 5 4 3 2 1 0
180 160 140 120 100 80 60 40 20 0
18 16 14 12 10 8 6 4 2 0
S.A.
6 5 4 3 2 0
120 100 80 60 40 0
12 10 8 6 4 0
TAS.
1 0
20 0
2 0

Fig. 1.

TABLE II.

Total tractive units on rural holdings (10 *horses* = 1 *tractor*) *by States, for the years* 1938-39 *to* 1947-48.

Season	Draught horses on rural holdings/10 + Tractors in:—					
	N.S.W.*	Vic.	W.A.	S.A.	Qld.	Tas.
1938-39	33,298					
1939-40	35,510	Draught horse numbers are not available.				
1940-41	35,885					
1941-42	34,329†					
1942-43	37,460	30,472	12,709	17,986	28,207	2,831
1943-44	36,094	29,528	12,527	17,608	27,972	2,836
1944-45	36,446	28,945‡	12,099	17,062	29,199	3,198
1945-46	35,682	29,125	12,056	17,011	30,275	3,462
1946-47	36,116	29,286	12,372	16,718	30,390	3,650
1947-48	35,665	30,059	12,718	16,163	31,158	3,713

*Draught horse numbers on rural holdings, as distinct from urban areas, were determined separately for 1946 only. The rural draught horse population in this column was arrived at by using the proportion of the rural draught horses to the total number of draught horses on the basis of the findings in 1946.

†It is thought that this figure was influenced by the diversion of tractors for war purposes.

‡Drought year. Some horses were not replaced immediately.

The figures in *Table II* show that by adding to the tractor figures the draught horse numbers divided by ten, a fairly constant figure is obtained for States other than Queensland and Tasmania. Thus, the increased tractor population does not mean the introduction of new tractive power to the farms, but rather the replacement of draught horses by tractors.

Caption for Fig. 1

Continuous thick line=Two yearly moving averages of p.k. sales plotted at the end point of each two-year period. (P.k. sales to the Armed Forces are excluded.)

Continuous thin line=Annual p.k. sales. (P.k. sales to the Armed Forces are excluded.)

Broken thin line=Tractor numbers on rural holdings.

Broken thick line=Draught horse numbers on rural holdings.

Dotted line=Crop acreage.

Note.—The scale for draught horses was so chosen that ten draught horses were taken equal to one tractor.

Not all data is shown for every year because the statistical records are incomplete.

In the 1939-40 season there was a panic buying of p.k.

AN EXAMINATION OF CERTAIN SELECTED AREAS IN VICTORIA

Data Used and Method of Computation

Three types of agricultural regions were selected for detailed study in Victoria to determine the p.k. consumption on tractor holdings. The counties of the Mallee and the Wimmera Districts were chosen for cereals, dried vine and citrus fruits; while the counties of the North Central District and the county of Buln Buln in Gippsland, were selected as typical for mixed farming.

The total number of tractors on rural holdings in Victoria, on the 31st March, 1948, was 16,295, and the total p.k. sales were 20,732,000 gallons during the 1947-48 fiscal year. Of these total figures the abovementioned selected areas had 7,574 tractors (46.5 per cent. of the State total) and a p.k. consumption of 11,214,000 gallons (54 per cent. of the State total).

The available p.k. sale figures for each parish were adjusted in proportion to the total sales in Victoria. Variation in the p.k. consumption within each District was expected and it was essential to establish the draught horse numbers on tractor holdings. Therefore, the cultivated acreage (excluding fallow) and the draught horse numbers on the tractor holdings were extracted from the Statistical Returns of the 31st March, 1948, separately for each holding in each parish. Having the data available for each parish, it became possible to treat different types of industry separately in determining their p.k. requirements.

Those counties of the Mallee which had only cereal production or grazing were treated as entire units; while in counties where certain parishes produced horticultural crops adjustment was made for the parishes which had any area of such crops. In the Wimmera where the fruit and grape acreages are relatively small and the p.k. distributing centres are widely scattered, the p.k. consumption was calculated for the total cultivated acreage of the tractor holdings in each county. In the counties of the North Central District and in the county of Buln Buln, acreages devoted to the different crops are interwoven, and grass hay harvesting is often a major operation carried out by tractors. Hence, in these counties, the dissection of the p.k. sales according to the type of production would not have any significance.

P.K. Consumption

Tables III-V show the p.k. consumption on tractor holdings in the various agricultural areas.

(a) *Wheat Growing Counties*

The figures in *Table III* show that the kerosene consumption per tractor in the Mallee counties is generally slightly higher than in the Wimmera. The reason for this is that the holdings in the Mallee are generally relatively larger than in the Wimmera, and, consequently, tractors in the Mallee have to cultivate and harvest a larger acreage. This is supported by the higher cereal acreage per tractor on the tractor holdings of the Mallee counties (*Table III, Column* 4).

In County **Millewa** cereal farming is economically marginal. Since much of the area is liable to wind erosion, farmers do not work their fallows at all during the summer period. The number of cultivations is therefore less than in other wheat growing counties—hence the lower consumption per tractor despite the high acreage per tractor.

Counties Weeah, Karkarooc and Tatchera all have a proportion of erodable soils, but the proportion of heavier type of soils is higher than in the Millewa. The consumption per tractor in these counties is remarkably uniform.

In **Counties Borung and Karakara** the cereal growing soils are generally heavy, some of them being of the well-known "Wimmera black" type. These soils require careful cultivation of the fallow during the summer. The average acreage per tractor is lower, but this is compensated for by the greater amount of work required if good crops are to be grown. The kerosene sales per tractor are therefore of the same order as in the more stable of the Mallee counties.

In **County Lowan** there is a considerable tract of good wheat soil on the Nhill-Serviceton line, but there is also a large area of country to the west of the Grampians where the system of cropping is less rigid. The kerosene used per acre

Tables III-V show for the tractor holdings in certain counties of Victoria the crop acreage, number of tractors, acreage per tractor, total p.k. sales and p.k consumption per acre and per tractor.

TABLE III

Data for tractor holdings in the main wheat growing counties.

District and County	Cereal acreage* (1000's acres)	No. of tractors*	Acres per tractor*	P.K. sales† (1000's gallons)	P.K. consumption (gallons) per acre	P.K. consumption (gallons) per tractor
Mallee						
Millewa	66.4	116	572	155	2.3	1,336
Weeah (eastern portion only)‡	93.7	168	557	326	3.4	1,940
Karkarooc	638.6	1,101	580	2,110	3.3	1,916
Tatchera	351.8	823	427	1,395	4.0	1,695
Wimmera						
Borung	500.2§	1,703	294	3,154	6.3	1,852
Kara Kara	160.0§	506	316	934	5.8	1,846
Lowan	247.7§	970	255	818	3.3	843

* At 31st March, 1948; † Year ending 30th June, 1948; ‡ The western portion of Weeah is supplied with p.k. through South Australia; § These figures are slightly over-estimated because they include a relatively small acreage under grapes and orchards.

TABLE IV

Data for tractor holdings in the dried vine and citrus fruit growing counties of N.W. Victoria.

County	Vine-citrus-vegetable acreage* (1000's acres)	No. of tractors*	Acres per tractor	P.K. sales† (1000's gallons)	P.K. consumption (gallons) per acre	P.K. consumption (gallons) per tractor
Karkarooc‡	19.2	792	24	626	32.6	790
Tatchera plus parishes of Benjerup and Murrabit West§	6.6	285	23	427	64.7	1,498

* At 31st March, 1948; † Year ending 30th June, 1948; ‡ Mildura district; § District centred on Swan Hill, Nyah, etc.

TABLE V

Data for tractor holdings in selected counties where mixed farming is practised.

District and County	Total crop acreage* (1000's acres)	No. of tractors*	Acres per tractor	P.K. sales† (1000's gallons)	P.K. consumption (gallons) per acre	P.K. consumption (gallons) per tractor
North Central						
Talbot	27.0	271	100	271	10.0	1,000
Dalhousie	3.7	116	32	155	41.9	1,336
Anglesey	3.4	119	28	105	30.9	882
Gippsland						
Buln Buln	14.2	604	23	738	52.0	1,221

* At 31st March, 1948; † Year ending 30th June, 1948.

TABLE VI

Showing in the main wheat growing counties of Victoria the number of tractor holdings, cereal acreage on these holdings, and the number and cereal acreage of those tractor holdings which had eight draught horses and over, at 31st March, 1948.

County	No. of tractor holdings	Cereal acreage on tractor holdings		Tractor holdings with eight draught horses and over	
		(1000's acres)	expressed as per cent. of the county's total cereal acreage	No. of holdings	Cereal acreage (1000's acres)
Millewa	119	66.4	60	7	5.1
Weeah	275	165.1	73	12	8.6
Karkarooc	1,016	638.6	73	58	43.3
Tatchera, plus parishes of Benjerup and Murrabit West	772	351.8	69	87	54.4
Lowan	942	247.7*	73	107	38.6
Borung	1,577	500.2*	77	111	46.8
Kara Kara	466	160.0*	69	45	17.9

* These figures are slightly over-estimated because they include a relatively small acreage under grapes and orchards.

TABLE VII

*Tractor holdings, at 31st March, 1948, in the county of Karkarooc, arranged according to their cultivated acreage and draught horse numbers.**

Acreage under cereals and hay	Draught horse numbers					
	0	1-2	3-4	5-8	9-12	12+
0-100	8	10	2	1	—	—
101-320	113	22	4	6	2	4
321-640	295	108	25	11	13	4
640+	222	99	25	21	11	9

* Tractor holdings with special crops (grapes, citrus) in the main grape and citrus growing parishes (Merbein, Mildura, Bumbang, Toltol) of Karkarooc are excluded.

TABLE VIII

*Tractor holdings, at 31st March, 1948, in the county of Borung arranged according to their cultivated acreage and draught horse numbers.**

Acreage under cereals and hay	Draught horse numbers					
	0	1-2	3-4	5-8	9-12	12+
0-100	94	44	9	9	1	1
101-320	450	153	49	29	28	7
321-640	356	120	30	21	30	9
640+	51	17	7	6	7	9

* Tractor holdings with special crop (grapes, fruit) in the main grape and fruit growing parishes (Quantong, Horsham, Jallukar, Conconcella) of Borung are excluded.

TABLE IX

Showing in the dried vine and citrus fruit growing counties of N.W. Victoria the number of tractor holdings, the vine-citrus-vegetable acreage on these holdings, and the number and vine-citrus-vegetable acreage of those tractor holdings which had three draught horses and over, at 31st March, 1948.

County	No. of tractor holdings	Vine, citrus and vegetable acreage on tractor holdings		Tractor holdings with three draught horses and over	
		(1000's acres)	expressed as per cent. of the county's total vine, citrus and vegetable acreage	No. of holdings	Vine, citrus and vegetable acreage (1000's acres)
Karkarooc*	762	19.2	58	17	1.1
Tatchera, plus parishes of Benjerup and Murrabit West†	265	6.6	50	27	0.9

* Mildura district; † District centred on Swan Hill, Nyah, etc.

TABLE X

Showing in the selected counties of Victoria where mixed farming is practised, the number of tractor holdings, total crop acreage on these holdings, and the number and total crop acreage of those tractor holdings which had four draught horses and over, or eight draught horses and over, at 31st March, 1948.

County	No. of tractor holdings	Total crop acreage on tractor holdings		Tractor holdings with four draught horses and over		Tractor holdings with eight draught horses and over	
		(1000's acres)	expressed as per cent. of the county's total crop acreage	No. of holdings	Total crop acreage (1000's acres)	No. of holdings	Total crop acreage (1000's acres)
Talbot	251	27.0	33	90	12.4	23	4.8
Dalhousie	106	3.7	23	14	1.0	1	0.1
Anglesey	112	3.4	38	11	0.6	1	0.1
Buln Buln	561	14.2	20	72	3.0	3	0.1

is therefore, on the average, low for the Wimmera, while the acreage per tractor also being low, the consumption per tractor must also be low.

These findings are for the cereal grain crops in the above-mentioned counties. The acreage figures on which the calculations are based include about 5 per cent. of cereals grown for hay, but as this requires about the same amount of power as growing for grain no error is involved. These findings show that, in the important areas of the wheat belt, the average tractor used about 1,650 gallons of p.k. in the 1947-48 season when harvesting was more difficult than usual due to the weather conditions.

(b) *Dried Vine and Citrus Fruit Growing Counties*

In the horticultural regions smaller tractors are normally used than in the

wheat growing regions, and the holdings are much smaller. Hence the kerosene consumption per tractor in these regions is smaller than in the wheat areas. Horticultural crops require much more intensive cultivation than cereals, therefore the kerosene consumption per acre cultivated is much higher. The figures for the horticultural regions are presented in *Table IV*.

The reason for the great difference between the kerosene consumption per tractor and per acre in the Mildura area and the Nyah-Swan Hill-Kerang area is threefold. Firstly, there is a much larger acreage cultivated by contractors in the latter area than in the former; since the tractors used by such contractors are not always included in the rural tractor population the consumption figures per tractor and per acre are high. Secondly, the Mildura area has a greater proportion of very light soils than the Nyah-Kerang area. Thirdly, considerably more vegetables are grown in the Swan Hill-Nyah area than around Mildura, and vegetable crops need more cultivation than either vines or citrus fruit.

(c) *Counties where Mixed Farming is Practised*

In the counties shown in *Table V* the p.k. consumption per tractor and per acre is generally between those of the wheat growing and grape-citrus producing regions. The intermediate kerosene consumption per tractor is due to the variability in the size of tractors used in mixed farming areas. The variety of crops grown in this region, coupled with grass hay production on a large scale, and with the hilly nature of parts of the countryside, make it unrealistic to expect very uniform figures from a broad statistical survey.

It must be understood that since the acreage figures in the *Tables III-V* refer to the tractor holdings only, and some farmers do contract work, the kerosene consumption per acre is somewhat overestimated. On the other hand, the tractor cultivated acreage is under-estimated.

Draught Horse Numbers

Tables VI-X show the number of draught horses on tractor holdings in the various agricultural areas.

(a) *Wheat Growing Counties*

The number of draught horses on the tractor holdings in all the selected wheat growing counties is shown in *Table VI*. In addition, the number of draught horses in the counties of Karkarooc and Borung is shown in more detail in *Tables VII and VIII* respectively.

The figures in *Table VI* show that only a small fraction (in terms of number of holdings as well as in terms of acreage) of the tractor holdings have 8 or more draught horses. Eight horses could be regarded as the minimum tractive power requirement in cereal production. *Tables VII* and *VIII* reveal the same picture, but these figures show also that the position is roughly the same on larger farms (over 320 acres of crop) as on the small (under 320 acres of crop).

(b) *Dried Vine and Citrus Fruit Growing Counties*

The figures in *Table IX* show that, as on the wheat farms, if tractors were not available, only a small proportion of the horticulturists would have a sufficient number of draught horses for their work. Three draught horses are generally necessary to work a horticultural holding without a tractor, although on the small holdings at least, two draught horses could possibly provide enough tractive power.

(c) *Counties where Mixed Farming is Practised*

The number of draught horses on the tractor holdings in all the selected mixed farming counties are shown in *Table X*. This Table indicates that, with the exception of the county Talbot, the proportion of the tractor holdings with sufficient draught horse numbers to do the work without a tractor is very small—quite regardless of whether four or eight draught horses are taken as the minimum power requirement.

Discussion and Conclusion

In the selected areas of Victoria it was found that:—

(a) The consumption of p.k. per tractor varies with the type of farming, locality and season.
(The consumption in the 1947-48 season was particularly high because of the unfavourable weather conditions at harvest, and the extra consumption may have involved up to a million gallons in Victoria and New South Wales combined.)

(b) On the majority of tractor farms the number of draught horses is insufficient to provide enough tractive power; this is just as true of small farms as of large.

The findings of the investigations of the selected areas in Victoria indicate that the effects of a reduction in the available p.k. would be either a proportional reduction in the cereal acreage, or less if the farmers decide to omit some cultivation before sowing. The latter alternative is, however, unlikely, because farmers seldom cultivate their land more than necessary. On the tractor holdings in the Mallee and Wimmera the acreage under cereal crop is about 73 per cent. of the total cereal acreage; while the corresponding figures for vine-citrus-vegetable acreage and cultivated acreage under mixed farming in the areas selected are 58 per cent. and 27 per cent. respectively. Due to some contract cultivation and harvesting the tractor cultivated acreage would be larger than indicated by these figures. Therefore, a reduced p.k. supply would affect cereal production most severely, horticultural production less severely, and least severely the production of the mixed farms—always assuming that the extra labour required for the slower horse work would be available.

Acknowledgments

I wish to thank Professor S. M. Wadham for much advice and criticism; the various oil companies and Mr. C. V. Brittain, of the Government Statist's Office, Melbourne, for providing the basic data; Messrs. E. J. Williams and R. Jardine for their help in the statistical analysis; and Mr. A. K. Ewart for his co-operation.

(Received for publication, 22nd December, 1948.)

TECHNICAL NOTES

FRUIT FLY BREEDING FOR EXPERIMENTAL PURPOSES — APPARATUS SUITABLE FOR BREEDING CERATITIS CAPITATA

Introduction

The Mediterranean Fruit Fly spends its larval life in the host fruit and when full grown, leaves the fruit and enters the soil where it pupates.

The normal procedure to obtain flies for experimentation has been to spread the infested fruit on trays of clean sand and allow the maggots when fully developed to leave the fruit and enter the sand to pupate. There are several objections to this method:—

1. It is necessary to make use of a large quantity of sand spread out in shallow trays over a considerable area in order to rear large numbers of flies.

2. As the fruit breaks down much of the liquor runs into the sand and cements it, and it is necessary to wash the sand through the sieve to obtain the pupae. The cemented clods and particles of sand make sieving difficult, with the result that very vigorous shaking is necessary to cause the sand to pass through the sieve.

3. The fruit bedded in the sand rapidly develops moulds, and if the fruit is at all closely packed in the trays the mould development causes the fruit to set into an impervious mass with resultant heavy mortality of maggots.

4. The handling of fruit under these conditions requires almost continuous attention and becomes very laborious.

Description of Apparatus

To overcome these difficulties, the following apparatus was constructed and in practice found to work efficiently. (Plan and elevation shown in fig. 1.) Six trays three inches deep with wire mesh bottoms are arranged above one another in a frame, with a space for aeration between the trays (see fig. 2). These trays are filled with infested fruit, and as the fruit breaks down the liquor drops through the fruit trays on to two sloping drip trays (see A in elevation). These trays conduct it to the edge of the drip trays where it drips on to the splash tray (see B in elevation) at the base where it is guided by means of a channel (provided with a lip) (C) to a suitable container.

The maggots when fully developed leave the fruit and fall to the drip trays (A). Their ability to jump usually takes them directly into the sand tray (D) where they burrow in and pupate. If they are carried down with the liquor to the splash tray they either crawl until they reach the sand or else they jump until they reach it.

By this means the liquor is separated from the maggots and the latter are able to pupate in a relatively small quantity of dry sand. The sand is sieved to remove the pupae and the sand tray refilled with clean sand and replaced.

The sand tray (D) consists of a shallow metal tray one inch deep with a face board (see (E) in plan) one foot high conveniently fitted over the draining channel (C).

When the tray is in position it is surrounded by a board one foot high on three sides and by the connecting flat iron on the fourth side. This is conveniently shown in fig. 4.

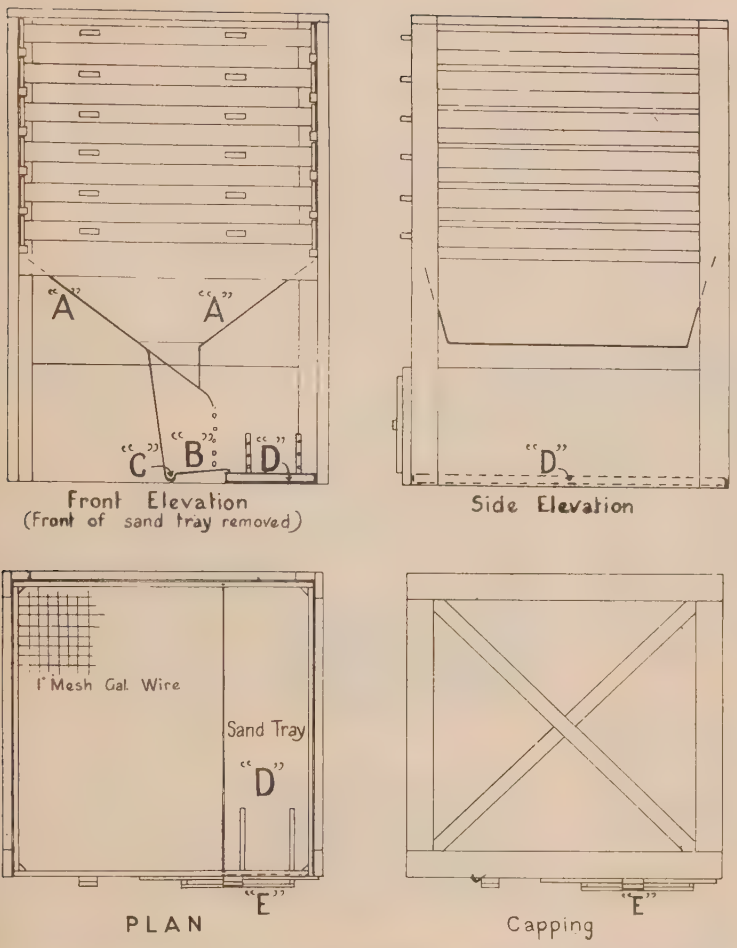

Fig. 1.

Fig. 1.—Scale diagram showing plan and elevation of the apparatus.

Fig. 2.—Photograph of the complete apparatus.

Fig. 3.—Apparatus with one fruit tray removed.

Fig. 4.—Apparatus with the sand tray removed.

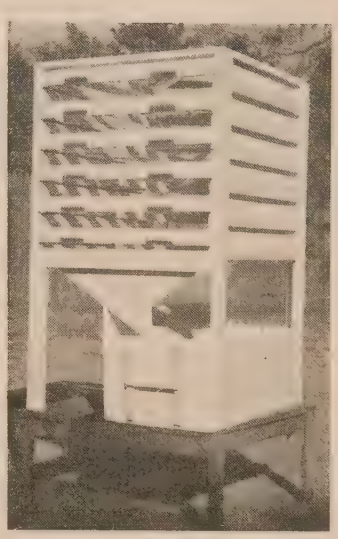

Fig. 2.

Fig. 3.

Fig. 4.

Each of the trays is constructed of galvanised iron and covered with several coats of gloss paint. All woodwork is given several coats of paint.

The apparatus as shown is capable of holding six to ten three-quarter bushel cases of fruit, depending on the size of the fruit. With heavily infested fruits, it is possible by means of this apparatus to extract up to 10,000 pupae per week.

With some fruits such as peaches and nectarines, and to a lesser extent apricots, in dry weather, the liquor dripping over the trays loses water and becomes sticky causing the larvae to adhere to them. This is overcome by moistening the trays with clean water once in twenty-four hours.

The larvae entering the sand tray pupate within twenty-four hours, and by frequent sieving of the sand it is possible to extract fully developed maggots just prior to pupation.

For ease of working, a flat-topped stand 12 to 18 inches high is necessary to facilitate the placing of the receptacle to catch the liquor and for removing and replacing the sand tray.

Protection against rats

The apparatus was set up and charged with fruit in a shed infested with rats. The rats dislodged the sand in the sand tray searching for larvae and pupae. It was obvious that the rats were eating many of the larvae and pupae. To overcome this a strip of fly wire gauze was stretched tightly across the top of the sand tray. The maggots crawl through this gauze very readily to reach the sand and the rats are prevented from disturbing the sand.

Acknowledgments

My thanks are due to Mr. W. M. O'Donnell who assisted in the perfection of the apparatus and suggested the use of the fly wire screen to exclude the rats, and to Mr. Garwell of the Government Workshops who supplied the constructional details of this piece of equipment.

F. E. RYAN,

Department of Agriculture, Western Australia.

(Received for publication, 12th April, 1949.)

DDT SPRAY INJURY TO PEARS

The phytotoxicity of DDT has been discussed by West and Campbell[1] and by Stoker[2]. The former authors summarize the work done on this subject up to about 1944. Stoker points out that DDT spray injury may be caused by constituents of the spray base as well as by DDT itself. These authors do not mention DDT spray injury to pears.

During the summer of 1948-49, the type of injury illustrated in the accompanying figure developed in Williams' Bon Chrétien and Packham's Triumph pears in a private garden in Canberra, after spraying with 0.1 per cent. DDT for codling moth control. The spray was prepared by mixing 0.5 per cent. of a commercial 20 per cent. DDT emulsion base with water. Applications were made when the fruits were about one-quarter, one-third, and two-thirds of their full size. As the spraying was for routine purposes only, the dates of application were not recorded. Each spraying was done with a knapsack sprayer, on a warm, calm, sunny day, applying enough to cause run-off. No other spray was applied.

No ill effects were noticed until the fruit was harvested, when it was found that about 30 per cent. of the fruit bore roughly circular markings of the type illustrated, from 1.5 to 2.5 cm. in diameter. These were situated either at the lowest point of the fruit as it hung on the tree, or at points where two fruits or a fruit and a branch touched. Excess spray would

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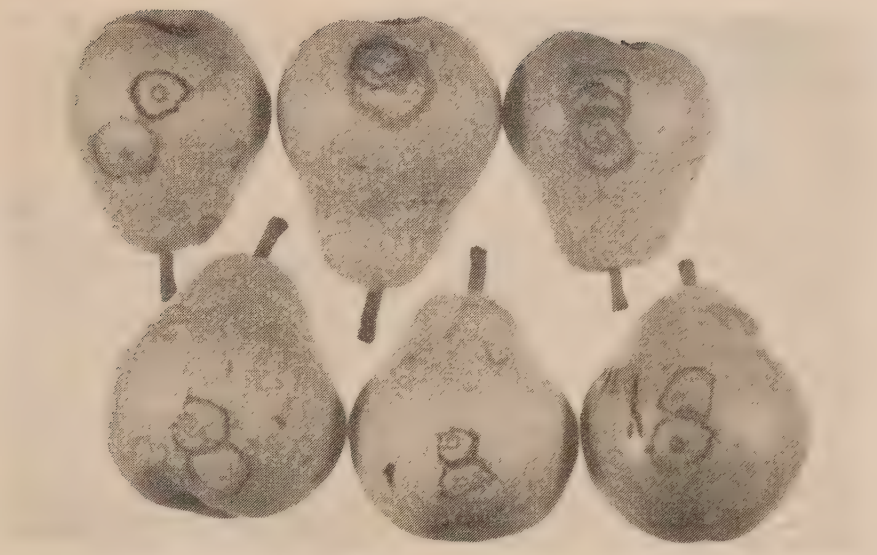

[Photo by J. Pomeroy.

Williams' Bon Chrétien pears, showing injury developed after spraying with 0.1 per cent. DDT emulsion.

tend to collect in large drops at these points. The main injury occurred round the circumference of each circle, and consisted of a slightly depressed ring of buff, brown, or brownish-black russeting of the skin. Within the ring there was a zone of normal skin surrounding a slightly russeted central area 3 to 5 mm. in diameter, on which there was often a whitish deposit, probably consisting mainly of solid DDT.

Often there were two or three more or less overlapping rings of varying diameters on the one fruit, the larger rings on such fruit appearing less heavily russeted at maturity than the smaller rings. In such instances it seems probable that the larger and less heavily russeted rings were caused by the earlier spray applications; as the fruit increased in size, the earliest formed rings would increase in diameter and the russeting would decrease in apparent intensity, being spread over a larger area than when it originally developed.

From the fact that the russeting was much more severe around the edge than in the centre of each circular area, although solid residues were confined to the centre, it is thought likely that the chief cause of injury was a volatile component or components of the emulsion base, rather than the DDT itself, which tended to accumulate in the centre of the evaporating drop. The injuries were confined to the skin, and did not affect the underlying tissue. When severe, they formed a conspicuous blemish, however, and would probably have reduced the market value of the fruit. It is likely that they could have been prevented by reducing the quantity of spray applied, hence avoiding excessive run-off. Granny Smith and Delicious apples sprayed under similar conditions showed no injury.

W. V. LUDBROOK,
Division of Plant Industry
C.S.I.R.O.,
Canberra, A.C.T.

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1. West, T. F., and Campbell, G. A., "DDT, the Synthetic Insecticide" (London, Chapman & Hall Ltd., 1946).
2. Stoker, R. I., *Ann. Appl. Biol.*, 35: 110, 1948.

(*Received for publication, 22nd April,* 1949.)

THIRTEENTH GENERAL MEETING

The Thirteenth General Meeting of the Australian Institute of Agricultural Science was held at the University of Tasmania, Sandy Bay, Hobart, on the 10th-11th January, 1949.

Annual Reports

The Report of Council* on Institute Activity for the year ending 31st December, 1948, was adopted. The Reports from the Business Manager and Editor of the Journal of the Institute for Volume 14 were adopted.

Statement of Accounts

The statement of accounts* was adopted. It was pointed out that the present favourable financial position of the Council was due primarily to (i) The abolition of branch grants and (ii) The re-introduction of advertising in the Journal.

Salaries and Status

During 1948, a Council sub-committee had recommended that branches adopt the C.S.I.R. scale of salaries and system of advancement as a basis for claims. Delegates reported on the steps taken by the various State Branches during the preceding year.

It appeared that in each State except New South Wales, graduates in agricultural science were considered to be of lower status than other professions, e.g. engineers.

The Public Service Commissioner in Western Australia had stated that there was little chance of improving conditions in that State, unless there was concerted action on the part of all States. Although the conditions in Tasmania were similar to those in Western Australia, the starting salary for agricultural scientists was the highest in Australia; however, this advantage faded out in subsequent years.

One delegate considered that a different approach was needed. He thought that State Governments should be influenced to set up a different body to fix salaries of professional workers, as at present the only thing that mattered was "the degree of scarcity of applicants for the various types of professional posts."

The following resolutions were adopted:

"That every effort be made by Council and Branch Committees to rectify the state of affairs under which employing authorities, particularly certain State Public Services, impose a lower status on Agricultural Officers as compared with other professional officers such as engineers, veterinary scientists, etc."

"That the question of status of the agricultural profession within such employing services as mentioned be considered as a major issue for investigation by the incoming council. That Council consider the possibility of co-operating with other organisations of professional workers with the object of pressing for the establishment of tribunals within or separate from States' Public Service Boards to control the appointment and the salary and status of professional workers."

"That Council consider the possibility of organising a concerted approach by the States to the Commonwealth Government with a view to a special grant to improve the salary and status of workers in Agriculture."

Journal Business

In its report, the Publications Committee pointed out that its policy was to publish a Journal which would be of interest to every member of the Institute, because to many members the Journal was their only real link with the Organisation. As the Journal of the Insti-

*The Annual Report of Council and the statement of accounts was published in the March issue of this Journal.

tute, it could not be solely a Journal of Agricultural Research. The Journal would continue to publish general articles on every aspect of agriculture, as well as serving as a publishing medium for research papers.

Finance prevented the Institute from having more publications. At present, it was not possible to provide free reprints of articles to authors.

The following resolution was adopted:

"That this meeting requests the Publications Committee to investigate, and, if desired, to make a recommendation to Council on the desirability of the appointment of another advertising representative with stronger interstate affiliations."

Rural Extension Services

After a very full discussion it was resolved:—

"That Council take action aimed at improving extension services throughout Australia and to this end investigate and where possible or desirable give effect to all or any of the following recommendations:

(a) To arouse public interest, especially amongst all types of Farmers' Organisations and Junior Farmer Movements, in the urgent need for improvement in extension services.

(b) To arrange for a visit to Australia by an overseas authority on extension services.

(c) To arrange conferences of extension workers, farmers and representatives of commercial and other interested organisations to discuss specific means of improving extension services.

(d) To enlist the interest of Federal and State Governments and/or Farmers' Organisations, Newspapers, Bankers, Broadcast Organisations, and other commercial concerns that might be prepared to assist in financing such a visit of an overseas authority."

Articles of Association

Amendments to the Articles of Association were adopted as follows:—

Article I—After the word "corporations" add the words "Council shall mean the Council of the Australian Institute of Agricultural Science.

Article 10b—Corresponding honorary members shall be persons in overseas countries elected by the Council of the Institute for the purpose of encouraging and assisting in the dissemination of knowledge in Agricultural Science and Practice.

Article 11(b)—Corresponding honorary members shall possess all the rights and privileges of financial corporate members but shall not be entitled to vote or to hold office.

Article 12—Honorary members and corresponding honorary members shall not be required to pay any subscription.

Article 15(a)—Persons residing outside the Commonwealth but otherwise eligible for corporate membership may apply to Council or to any Branch for a Membership Application form which shall upon completion be submitted to the Council. Council shall then consider the application and same shall be approved provided it receives the vote of two-thirds of the members of Council.

Article 25(a)—A member resident in the marginal area of any State, adjacent to another State or States shall, with the consent of the Branches concerned and with the approval of Council, have the right to membership in whichever of the Branches he desires.

Article 31—Add the words "provided that decisions made at a General Meeting of the Institute shall be binding upon Council."

Article 34.—At the end of the Article add the words, "and, in this case, the delegate thus acting as Chairman, shall appoint a proxy delegate to act on his behalf at any or all meetings at which such delegate acts as Chairman."

Interchange of Personnel

A copy of a review of Council efforts to facilitate the interchange of scientific agricultural personnel was tabled. It was resolved:—

"That this meeting is perturbed at the continuance of restrictions on free inter-

change of scientific personnel between the State and Commonwealth Public Service and calls on the Council to take more effective action to have the restrictions removed."

Agricultural Engineering

After a paper prepared by Mr. G. H. Vasey was read, it was resolved:—

"That this meeting believes that intensified teaching and research in Agricultural Engineering is needed in Australia in order to promote continued improvements in agricultural production, and directs Council to the need for obtaining from Branches reports on the present situation in this regard and the obvious need for amendments thereto, and thereafter submitting a full memorandum on the subject to the appropriate Federal and State authorities.

Scholarships for Agricultural Graduates

The report prepared by the sub-committee on scholarships was presented. It was resolved:—

"That the scholarship sub-committee report be submitted to Council and passed by the Council to Branches for checking; and that Branches be asked to comment and make suggestions for improvement of the position of scholarships."

Transfer of Office of Management

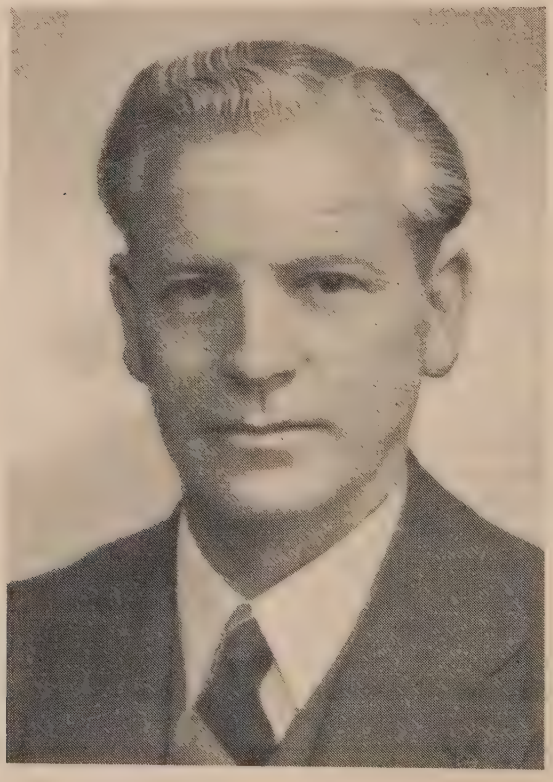
It was agreed "That the office of management for the next four-year period be transferred from New South Wales to Canberra."

It was resolved "That the New South Wales Branch be thanked for having carried the burden of the management for the past four years."

Installation of Incoming President

Professor J. R. A. McMillan was installed as President of the Australian Institute of Agricultural Science for the forthcoming year.

THIS YEAR'S PRESIDENT



PROFESSOR J. R. A. McMILLAN

COUNCIL PROCEEDINGS

March Meeting

A meeting of Council was held at C.S.I.R.O., Canberra, on Wednesday, 2nd March, 1949.

Present

Professor J. R. A. McMillan (in Chair); Dr. T. H. Harrison (A.C.T.); Mr. C. M. Donald (N.S.W.); Dr. W. V. Ludbrook (Tas.); Mr. C. S. Christian (Q'ld.); Mr. P. A. Reid (Vic.); Dr. D. O. Norris (W.A.); the Hon. General Secretary (Mr. G. A. McIntyre), and the Hon. General Treasurer (Mr. W. Ives).

Resolutions from General Meeting

Salaries and Status

A sub-committee, consisting of the proxy delegates from Western Australia and Victoria and the Australian Capital Territory delegate was appointed to prepare a report and plan of action for consideration by Council.

Rural Extension Services

It was resolved that:—

"In connection with Rural Extension Services this Council considers that a prerequisite to action in terms of the instruction from the 13th General Meeting under Resolution on Item 6, is a factual statement regarding extension services in each State and Territory and calls upon each State to prepare such a statement for consideration by Council."

"That this Council approach the Australian Agricultural Council requesting that that Council should take steps to arrange through F.A.O. of U.N.O. for a visit to Australia by an authority in Agricultural Extension Services from the United States of America."

Articles of Association

"That this Council appoints Messrs. Donald, Christian, Ludbrook and Norris as a committee to draft for consideration of delegates the required verbal amendments to related articles consequent upon amendments to the Articles of Association adopted at the Thirteenth General Meeting."

Interchange of Personnel

Council decided that the only immediate action was to enquire into the reception given, and action taken by Commonwealth and State authorities with respect to the letter forwarded by the Joint Committee of Professional Associations.

Representation of A.I.A.S. at Pacific Science Congress

The Hon. Secretary reported that Mr. A. M. Stewart had accepted the invitation to represent the Institute, and that the Organising Secretary of the Congress, Dr. G. Archey, had accepted our representation.

Report of Qualifications Committee

The report of the Qualifications Committee was received. During the period 1/1/48 to 31/12/48, forty-nine applications for Corporate Membership and fifty-seven applications for admission to Student Membership were received for examination and report. Favourable recommendations were made in all cases and were accepted by Council.

The report states that the Qualifications Committee received with appreciation the decision of Council, "to receive applications for admission to Student Membership, which had received favourable reports from Branch Committees, direct, and not to ask for the report of the Qualifications Committee in these cases."

It was resolved:—

"That the present Qualifications Committee, located in Victoria, be thanked for its able work during its current period of office and be requested to continue in office until the end of 1949; and that the Council determine at a later date, whether a Committee be appointed in another State to function as from the commencement of 1950."

Membership

The following transfers were noted:—

Mr. R. W. Wilson — from A.C.T. to N.S.W.

Mr. K. D. Nichols — from Vic. to Tas.

The resignations of Mr. R. P. Dodd and Mr. H. F. Clarke were accepted with regret.

Resignation of Business Manager

Mr. W. J. Webb tendered his resignation due to the fact that he is taking up residence in the country. Council regretted losing his services and expressed appreciation for the work he had done on behalf of the Institute.

April Meeting

A meeting of Council was held at C.S.I.R.O., Canberra, on Tuesday, 5th April, 1949.

Present

Professor J. R. A. McMillan (in Chair); Dr. T. H. Harrison (A.C.T.); Mr. C. M. Donald (N.S.W.); Mr. C. H. Williams (S.A.); Dr. C. Barnard (Tas.); Mr. C. S. Christian (Qld.); Mr. P. A. Reid (Vic.); Mr. F. O. Grogan (W.A.); the Hon. General Secretary (Mr. G. A. McIntyre) and the Hon. General Treasurer (Mr. W. Ives).

Apologies were received from Dr. W. V. Ludbrook, Dr. C. Barnard acting as alternative proxy for Tasmania.

Constitution of Council

Advice was received regarding the appointment of the following principal delegates:

Dr. T. H. Harrison (A.C.T.); Mr. R. I. Herriot (S.A.); Mr. E. J. Breakwell (N.S.W.); Mr. C. W. Winders (Q'ld.); Mr. W. F. Walker (Tas.); also regarding the following proxy delegates, Mr. C. H. Williams (S.A.); Mr. C. M. Donald (N.S.W.); Mr. C. S. Christian (Q'ld.), and Mr. F. O. Grogan (W.A.).

Auditors

It was resolved, "that the firm of Allard, Way and Hardie, London Circuit, City, Canberra, be asked to act as auditors to the Institute."

Salaries and Status

The report of the sub-committee appointed at the last meeting was considered by Council.

It was agreed that letters be written to the Professional Officers Association to ascertain their attitude with respect to the formation of independent tribunals for consideration of professional salaries, or alternatively, of professional representation on Public Service Boards and/or in Arbitration.

It was resolved that "a survey of the present position with respect to professional salaries in the Commonwealth Public Service" be carried out.

It was considered that the status of professional workers would be enhanced by publicity such as authorised public statements by the Institute on agricultural questions of current national importance.

Annual Meeting—1950

It was resolved "that the next Regular General Meeting of the Institute be held in March, 1950, at Canberra."

Finance

In view of the present bank balance, it was resolved "that the sum of £200 be invested in Commonwealth Treasury Bonds, to be lodged for safe custody with the Commonwealth Bank, Canberra."

Having received the recommendation of the Branch submitting the application, the following were admitted to Student Membership:

Galletly, J. G. (Q'ld.).

Fox, N. F. (Q'ld.).

The following *transfer* was noted:—

Williams, C. H., S.A., to A.C.T.

The Membership of the following student members was *cancelled* by graduation:—

New South Wales

Atkins, B. F.
Barbour, R. H. H.
Braithwaite, B. M.
Campbell, Margaret.
Darley, E. C.
Dillon, J. J.
Feilen, P.
Gardner, F. J.
Humphreys, L. R.
Hunt, D. M.
Kyneur, G. W.
Lamrock, J. C.
Litchfield, W. H.
Long, J. K.
Mears, J.
Mosschel, J. R. G.
Morris, J. A.
Manton, R. K.
Penny, Monica.
Potter, J. N.
Robertson, Cuninghame, R. C.
Sorensen, T.
Stern, W. R.
Watson, K. A.
Wyndham, Lucinda.
Young, J. G.

South Australia

Kentish, T. D.	Edwards, G. R.
Carter, E. D.	Barrow, P. M.
Beck, M. B.	Trumble, H. P. C.
Cant, R. R.	Till, M. R.

The student membership of Nicholson, L. N. (S.A.), was *cancelled* as he is no longer eligible.

Resignations

The resignations of Mr. W. G. Spafford (S.A.) and Dr. J. Calvert were received with regret. A note of appreciation of his services to Agriculture and the Institute was sent to Mr. Spafford by the President.

Journal Business

An audited Balance Sheet of Journal Business for the period 20/4/48 to 21/2/49, which was the date of retirement of Mr. W. J. Webb from the position of Business Manager, was received.

On the recommendation of the Victorian Branch Committee, the following members of the Publications Committee were appointed:—

Business Manager: Mr. P. A. M. Bell.

Assistant Business Manager: Mr. J. S. Orr.

BRANCH NOTES

AUSTRALIAN CAPITAL TERRITORY.

The Annual General Meeting of the Branch was held on 15th March, 1949. The following office-bearers were elected for the ensuing year:—

President: Dr. T. H. Harrison.
Hon. Secretary: Mr. R. D. Brock.
Hon. Treasurer: Mr. C. E. W. Moore.
Hon. Sub-Editor: Mr. G. A. H. Helson.
Committee Member: Mr. P. G. Phillips.
Auditors: Mr. K. Loftus Hills, Mr. T. G. Campbell.

The Presidential address entitled "Australia's First Line of Defence" was delivered by Dr. T. H. Harrison.

NEW SOUTH WALES

The Fourteenth Annual General Meeting of the Branch was held on 18th February, 1949. The following office-bearers were elected for the ensuing year:—

President: Mr. W. W. Jones.
Vice-President: Dr. F. T. Bowman.
Hon. Secretary: Miss Helen Wrigley.
Hon. Treasurer: Mr. K. E. Hutton.
Hon. Sub-Editor: Mr. S. M. Sykes.
Publicity Officer: Mr. F. Butler.
Committee Members: Messrs. E. J. Breakwell and J. R. G. Morschel.

The Presidential address entitled "Advances in Horticultural Practice" was delivered by Dr. F. T. Bowman.

A general meeting of the Branch was held in Science House on 22nd April, 1949, when Dr. R. J. Swaby spoke on "Microbiology and Soil Fertility" being a review of his recent work at Rothamstead.

QUEENSLAND

The Annual General Meeting of the Branch was held on 1949. The following office-bearers were elected for the ensuing year:—

President: Mr. C. W. Winders.
Vice-Presidents: Messrs. A. R. Brimblecombe and C. G. Hughes.
Hon. Sec.-Treasurer: Mr. F. Chippendale.
Hon. Sub-Editor: Mr. P. J. Skerman.
Committee Members: Prof. L. J. H. Teakle, Messrs. N. E. H. Caldwell and S. Sloan.

SOUTH AUSTRALIA

The Annual General Meeting was held on 14th March, 1949. The following office-bearers were elected:—

President: Mr. R. I. Herriot.
Vice-President: Prof. H. C. Trumble.
Hon. Secretary: Mr. P. F. Butler.
Hon. Treasurer: Mr. K. Woodroffe.
Hon. Sub-Editor: Mr. C. G. Stephens.
Committee Members: Messrs. R. N. McCulloch, D. S. Riceman, H. K. Kemp, D. B. Adam.

The Presidential address entitled, "University Training in Agricultural Science", was delivered by Professor Trumble.

This was preceded by an address by Dr. E. S. Archibald, of the Canadian Science Service. Dr. Archibald conveyed to the South Australian Branch of the Australian Institute of Agricultural Science, the goodwill of the Agricultural Institute of Canada. He then dealt with a number of aspects of organisation of both research and extension in the agricultural sphere in Canada. He mentioned the efforts of the Canadian Institute in obtaining 50,000 dollars for research grants, each of 1,000 dollars, by means of approaches to agricultural and related industries. He then outlined the functions of the four principal departments dealing with agriculture — namely:—Production, Marketing, Swine Service and the Experiment Farm Service, the latter principally covering horticultural, cereal, forage, tobacco and fibre crops. He also mentioned and outlined the function of the Illustration Stations which are purely demonstrative in character.

In dealing with the history of soil conservation in Canada, he included reference to the nature of the erosion problem, the administration and organisation necessary to cope with it, and some aspects of associated research work.

Brief mention was made of some specific problems such as stem and leaf rust in cereals, research on grasses such as crested wheat grass, declining humus content of certain soils and the need for legumes in particular regions. In concluding, Dr. Archibald expressed an interest in and hope for more activity in the exchange of personnel.

VICTORIA

The fourteenth Annual General Meeting of the Branch was held on 13th May, 1949. The following office bearers were elected for the ensuing year:—

President: Dr. H. C. Forster.
Vice-President: Mr. R. D. Croll.
Immediate Past President: Mr. P. J. Mitchell.
Hon. Secretary: Mr. L. L. Stubbs.
Hon. Treasurer: Mr. T. W. Hogan.
Hon. Assistant Secretary: Mr. H. Freeman.
Hon. Sub-Editor: Mr. A. J. McIntyre.
Committee Members: Professor S. M. Wadham, Dr. I. J. Phipps, Messrs. L. R. Hoult, Munch-Peterson and A. Shavitsky.

PERSONAL

Australian Capital Territory

Mr. K. R. Norris, of the C.S.I.R.O. Division of Economic Entomology, recently left Australia for study leave at Oxford University.

Mr. E. M. Hutton, of the C.S.I.R.O. Division of Plant Industry, recently left Australia for study leave at Rothamstead.

New South Wales

Dr. V. M. Lewis recently returned to Sydney after an absence of nearly three years in the United States, the United Kingdom and several European countries. He was awarded the Doctor of Philosophy by the University of Massachusetts for a thesis entitled "Studies on the Enzymatic Browning of Food Stuffs". This work was carried out under the direction of Dr. Carl Fellers, who spent some time in Australia with the United States Forces during the war.

Dr. R. L. Reid has returned to the McMaster Animal Health Laboratory of the C.S.I.R.O. He obtained the degree of Doctor of Philosophy at the University of Cambridge, for research on "Carbohydrate Metabolism of Sheep".

Dr. E. P. Baker, 1947 Pawlett Scholar, has returned from the University of California, where he presented a thesis on "The Inheritance of Resistance to Bunt in Certain Wheat Crosses". He is continuing his investigations on the genetics of disease resistance at the University of Sydney.

Mr. J. M. Vincent, Senior Lecturer in Agricultural Bacteriology at the University of Sydney, has been awarded a Carnegie grant. He has left for the U.S.A. and Europe, where he will visit universities and research institutions conducting research in Agricultural Bacteriology.

Mr. R. C. Robertson-Cunninghame, a student member of the Institute, has been selected as the New South Wales Rhodes Scholar for 1949.

Queensland

Mr. J. E. C. Aberdeen has resigned his position as Plant Pathologist, Queensland Department of Agriculture, to take up an appointment as Assistant Lecturer in Botany at the University of Queensland.

Mr. R. F. N. Langdon, lecturer in Botany at the University of Queensland, has been awarded one of the two Nuffield Foundation Travelling Fellowships available to scientists in Australia. During the war, he was mentioned in dispatches for distinguished service as Commanding Officer of a Malaria Control Unit in New Guinea. He will leave Australia in August to study Plant Pathology at the University of Cambridge and at the Commonwealth Mycological Institute, Kew.

Mr. W. A. McDougall, Senior Entomologist with the Bureau of Sugar Experimental Stations, has been awarded the degree of Doctor of Science by the University of Queensland. His thesis, "An ecological study of rats of economic importance in Queensland canefields," is regarded as one of the most important contributions to the science of ecology. The work was divided into six parts, the first two deal with economic aspects, species and general habits. Subsequent sections are devoted to laboratory experiments on food intake and toxicity, breeding and life histories, population and, finally, control. The investigations were centred on Mackay in Central Queensland, and the fact that new ground was being broken, combined with the isolation from other scientific workers, added to the merit of the work.

South Australia

Mr. H. R. Marston, Chief of the C.S.I.R.O., Division of Biochemistry and General Nutrition, Adelaide, has been elected as a Fellow of the Royal Society. This award is the culmination of long

researches by Mr. Marston and his co-workers into the nutritional requirements of merino sheep. This work led to the discovery that coast disease in sheep was the result of cobalt deficiency. A further discovery was that "steely" wool could be eliminated by feeding small quantities of copper to the sheep. The most recent work has been the discovery that large areas of pastures in the Ninety Mile Desert region of South Australia receiving an annual rainfall of between 15 to 20 inches can be brought into productivity by the addition of small quantities of copper and zinc.

Victoria

Mr. J. A. Aird, who for many years has been an officer of the State Rivers and Water Supply Commission, was recently appointed a Commissioner.

Mr. R. D. Croll has left his position with Drug Houses of Australia Ltd., where he was in charge of the Developmental Division to take up the post of Assistant to the General Manager of Eagley Mills, Foy & Gibson Ltd.

Dr. I. F. Phipps, of I.C.I.A.N.Z. Ltd., left for a visit overseas last March. He will be away for several months.

Associate Professor G. W. Leeper, who has been overseas since August, 1948, returned this month.

Mr. L. H. P. Jones has been awarded the degree of Doctor of Philosophy by the University of Melbourne for his thesis on "The Oxides of Manganese and Their Relation to the Availability of Manganese to Plants in Soils."

Mr. W. J. Webb has resigned as Business Manager of this Journal, a position he has held since the Publications Committee has been situated in Melbourne. Mr. Webb, who was formerly Victorian Sales Manager for I.C.I.A.N.Z. Ltd., has taken up farming at Goorambat, near Benalla.

Mr. G. C. Stubbs has been awarded the degree of Master of Agricultural Science for his thesis "The Etiology and Control of White Rot Disease of Onions."

Mr. J. C. Walsh has resigned from the Victorian Department of Agriculture to take up a position in the Department of Commerce and Agriculture.

Miss Nancy Millis, formerly a Field Officer in New Guinea, has fully recovered from her serious illness, and has recently left for England to undertake further post-graduate studies.

Western Australia

Mr. A. M. Stewart, senior lecturer in Agriculture at the University of Western Australia, is at present on study leave. After attending the Pan Pacific Congress in New Zealand, he proceeded to the United States, where he will visit laboratories and field stations connected with animal nutrition investigations.

Mr. F. O. Grogan, who previously was stationed in Perth attached to the War Service Land Settlement Division of the Ministry of Post War Reconstruction, has now taken up an appointment with the Department of Commerce and Agriculture in Canberra.

Mr. A. J. Millington has resigned his appointment as senior lecturer in Agriculture and Plant Breeder at Roseworthy Agricultural College, South Australia, to take up a research fellowship in the Institute of Agriculture of the University of Western Australia.

Mr. H. R. Powell, Superintendent of Horticulture of the Department of Agriculture, has been seconded to the Department of Commerce and Agriculture as Acting Fruit Officer stationed at Australia House, London. He expects to be in London for about eight months. During his absence abroad, *Mr. R. C. Owen* has been appointed as Horticultural Officer.

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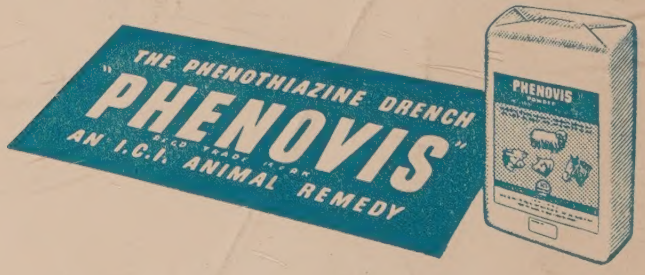

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